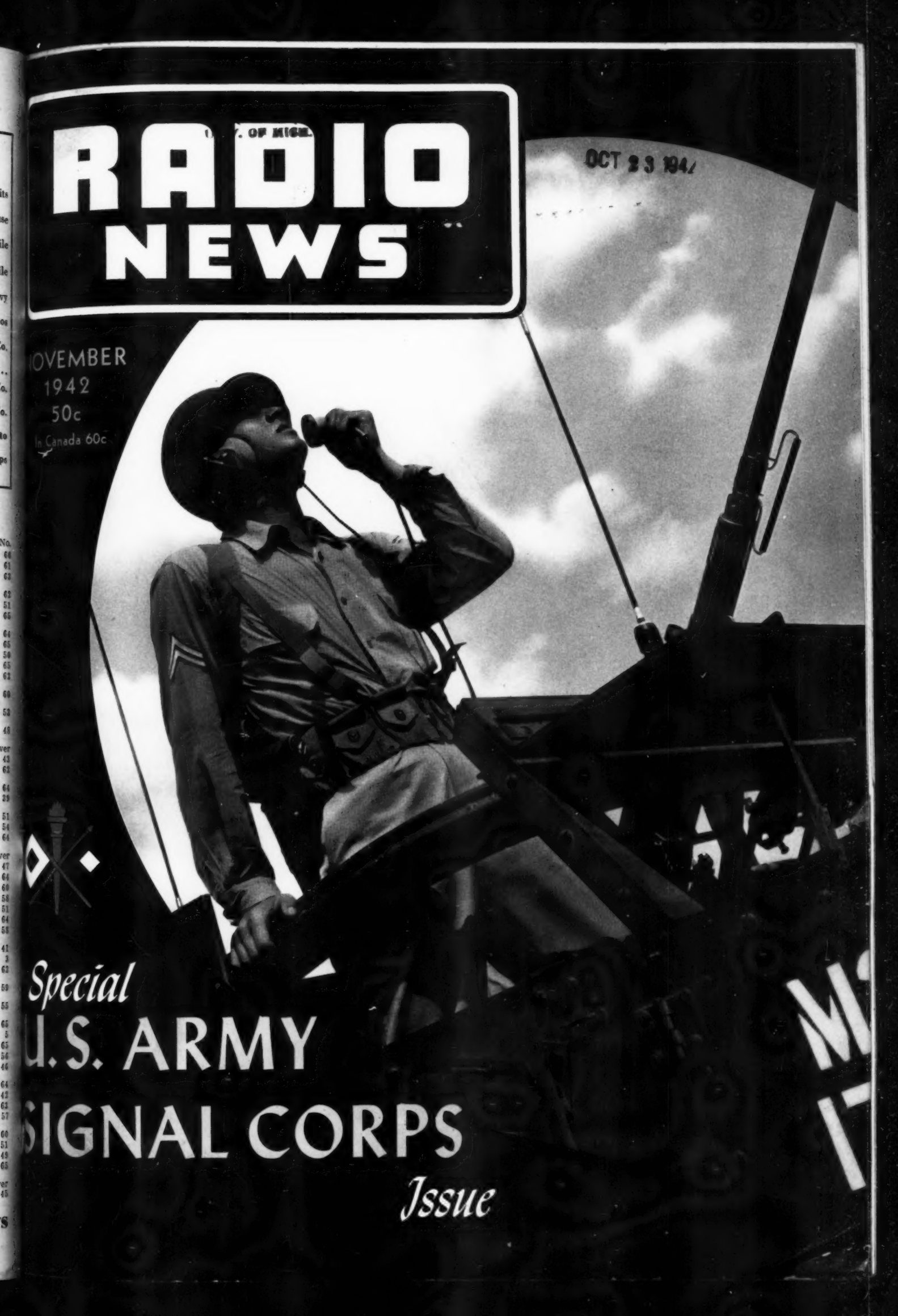
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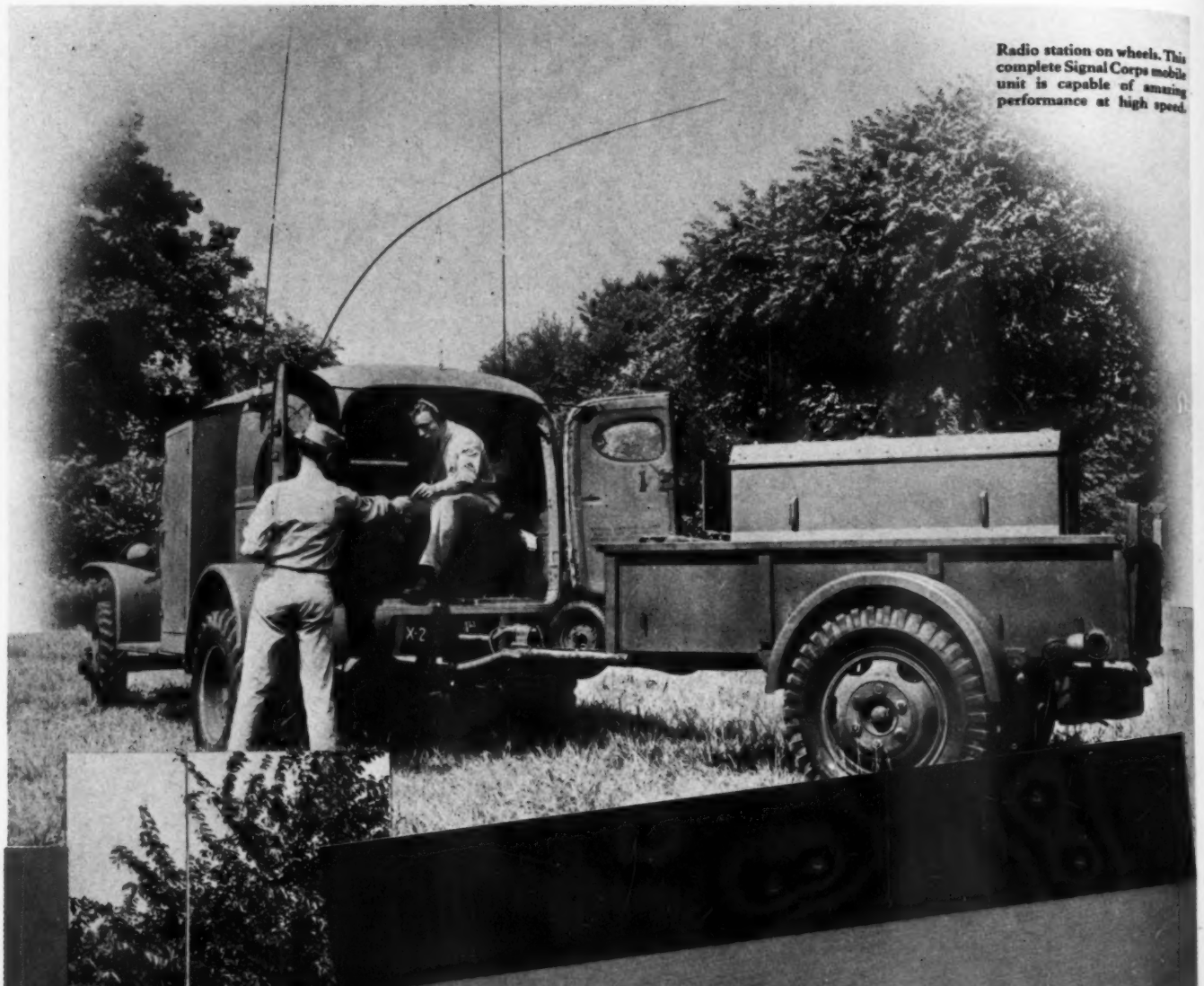

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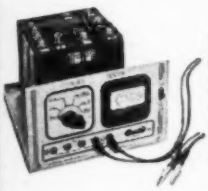

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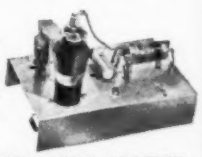

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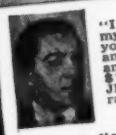
TRAINING MEN FOR VITAL RADIO JOBS

These Men Have SPARE TIME BUSINESSES



"I repaired some Radio sets when I was on my tenth lesson. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half. I have made an average of $10 a week—just spare time."—JOHN JERRY, 1337 Kalamath St., Denver, Colorado.

"I do Radio Service work in my spare time only, operating from my home, and I net about $40 a month. I was able to start servicing Radios 3 months after enrolling with N. R. I."—WM. J. CHERMAK, R. No. 1, Box 287, Hopkins, Minn.

"I am doing spare time Radio work, and I am averaging around $500 a year. Those extra dollars mean so much—the difference between just barely getting by and living comfortably."—JOHN WASHKO, 97 New Cranberry, Hazleton, Penna.

These Men Have FULL TIME BUSINESSES

"For several years I have been in business for myself making around $200 a month. Business has steadily increased. I have N. R. I. to thank for my start in this field."—ARLIE J. FROEHNER, 300 W. Texas Ave., Goose Creek, Texas.

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If the jobs held by the men above sound good to you, mail the Coupon for a FREE lesson from my Radio Course. See for yourself how my "50-50 Method" has trained thousands for better jobs—how it can train YOU at home in spare time. Many N. R. I. students make $5, $10 a week extra fixing Radios in spare time while still learning. I send EXTRA MONEY JOB SHEETS that tell how to do it.

With this Trial Lesson I'll send my 64-page book, RICH REWARDS IN RADIO. It describes the many fascinating jobs Radio offers; explains how N. R. I. teaches you. You'll see why my Lessons offer **a quick way to more pay.** And even if you never go any farther, this Trial Lesson is worth having. I will send it to you without obligation. MAIL THE COUPON!

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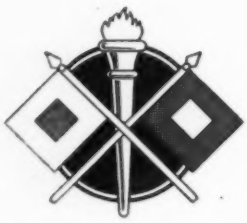
RADIO NEWS

Volume 28 Number 5 NOVEMBER, 1942

SPECIAL U. S. ARMY SIGNAL CORPS ISSUE



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Foreword

NAPOLEON said that an army operates on its belly. A modern army operates on its communications systems. Modern war has placed a premium on the ability to get to a threatened sector in a hurry with all the power which can be brought up. For purposes of either defense or offense, to get there with "too little" or to get there "too late" is a historical definition of defeat.

One of the most potent elements in modern war, and without which any campaign must fail, is the communications systems, dominated by radio. The communications and reconnaissance systems of the past are now as dead as the dodo. A single man may direct the entire course of battle by radio from the skies above. An air battle may be handled from the ground; men 500 miles away may be brought up to a critical sector on wings by the use of short-wave methods in a matter of hours. Radio plays an important part in all factors which relate to war, in industry and economics as well as in the field.

The history of the United States Army Signal Corps glows with a long record of achievement. Its efficiency is known throughout the world. It is important to all Americans associated with this war in any capacity—military, political or industrial—that they understand the structure of this immensely important section of our national army, its inception, growth and character as well as the gigantic task for which it is designed.

This analysis has been specially prepared by the officers and personnel of the Signal Corps. It presents a graphic account of this important portion of our armed forces, and it tells as much as can be told within the limits of security, about the new methods which have been devised and the new techniques which are now operative.

We of RADIO NEWS are proud to present this tremendous story ot one of the most brilliant and powerful branches of the American armed services.

William B. Ziff

Publisher, RADIO NEWS

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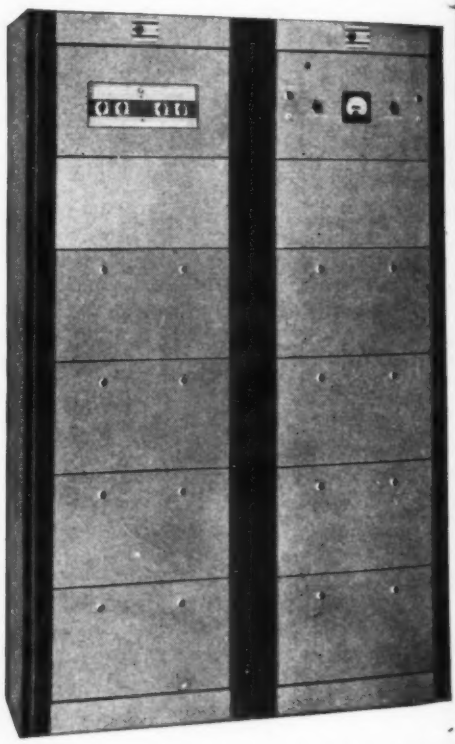

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Introduction

NEVER in history has the problem of supply been so vital to victory as in the grim struggle which has aligned the United Nations against the evil forces of the Axis. This War for Survival has rightly been termed a war of production, in which the courage and devotion of men fighting in defense of free institutions can attain the final triumph only as the workers and the factories of the homeland back them up with ever increasing stores of the most powerful weapons which intelligence can devise.

But as warfare has come to call for the rigorously calculated deployment of vast masses of mechanized might—mobile guns, tanks, troop carriers, surface vessels, submarines, and airplanes—one particular phase of the problem of supply has become of crucial central importance. This is the supplying of information—the right information, swiftly and accurately transmitted to the right place, at the right time. Without this, all else fails, for without it the close-working co-operation of varied forces moving at great speeds becomes impossible, control is lost, command is balked.

The Signal Corps of the Army of the United States is expected to "get the message through" — to establish and maintain swift and accurate communication wherever the lines of battle may be drawn. It is therefore in this war charged with the heaviest responsibilities in its history. We may look with confidence for the devoted performance of those responsibilities, and to the victory to which that performance will so greatly contribute.

ROBERT P. PATTERSON
Under Secretary of War

☆ HOW IT ALL BEGAN ☆

General Orders No. 17, dated July 2, 1860, contained an entry from which has grown the Signal Corps of today.

by Maj. Gen. DAWSON OLMSTEAD

Graduated from the U. S. Military Academy in 1906. Born at Corry, Penn. Served on staff of Inspector General of the A.E.F. in France, as Signal Officer of the Fourth Corps Area, now the Fourth Service Command; as Department Signal Officer for Hawaii; in charge of the Alaska Communications System; as executive for the Chief Signal Officer, Washington, D.C.; and as Commandant of the Signal Corps School at Fort Monmouth, N. J. Is a graduate of the Signal Corps School, a distinguished graduate of the Command and General Staff School and a graduate of the U. S. Army War College. Major General Dawson Olmstead became Chief Signal Officer in 1941.

DEVELOPED in the United States and copied by all the great armies of the world, the Signal Corps of the United States Army can rightly lay claim to the title of the all-American branch of the service. The Corps, whose primary duty is the establishment and maintenance of communications wherever and whenever military needs demand, thinks of its job as that of getting the message through, no matter what the obstacles and difficulties may be. For something more than eighty years, the men of the Signal Corps have been doing just that—getting the message through—in all parts of the world, under widely varying conditions, with the aid of every instrumentality that science and engineering can provide, with the drive and spirit that can be had only from the proud tradition achieved in the past.

The story of the Signal Corps really divides itself into two parts, with the line of demarcation in the late 1890's and early 1900's, when radio and airplanes began to take their places among the weapons of war. The development of these two implements, which are so closely interrelated, gave breathtaking speed to attack, and consequently put a new emphasis on the necessity of swift and reliable transmission of intelligence. The second chapter of the Signal Corps' history is an impressive record of the vital and vigorous utilization of electronic wizardry, both to aid our own nation's forces in making the best possible use of the airplane, and to combat to the greatest extent the efforts of our enemies to employ the airplane against us. The end of this chapter has not yet been reached; the present titanic struggle between the united forces of democracy and Nazi power has already added glorious achievements to it, and may be expected to produce others still more notable.

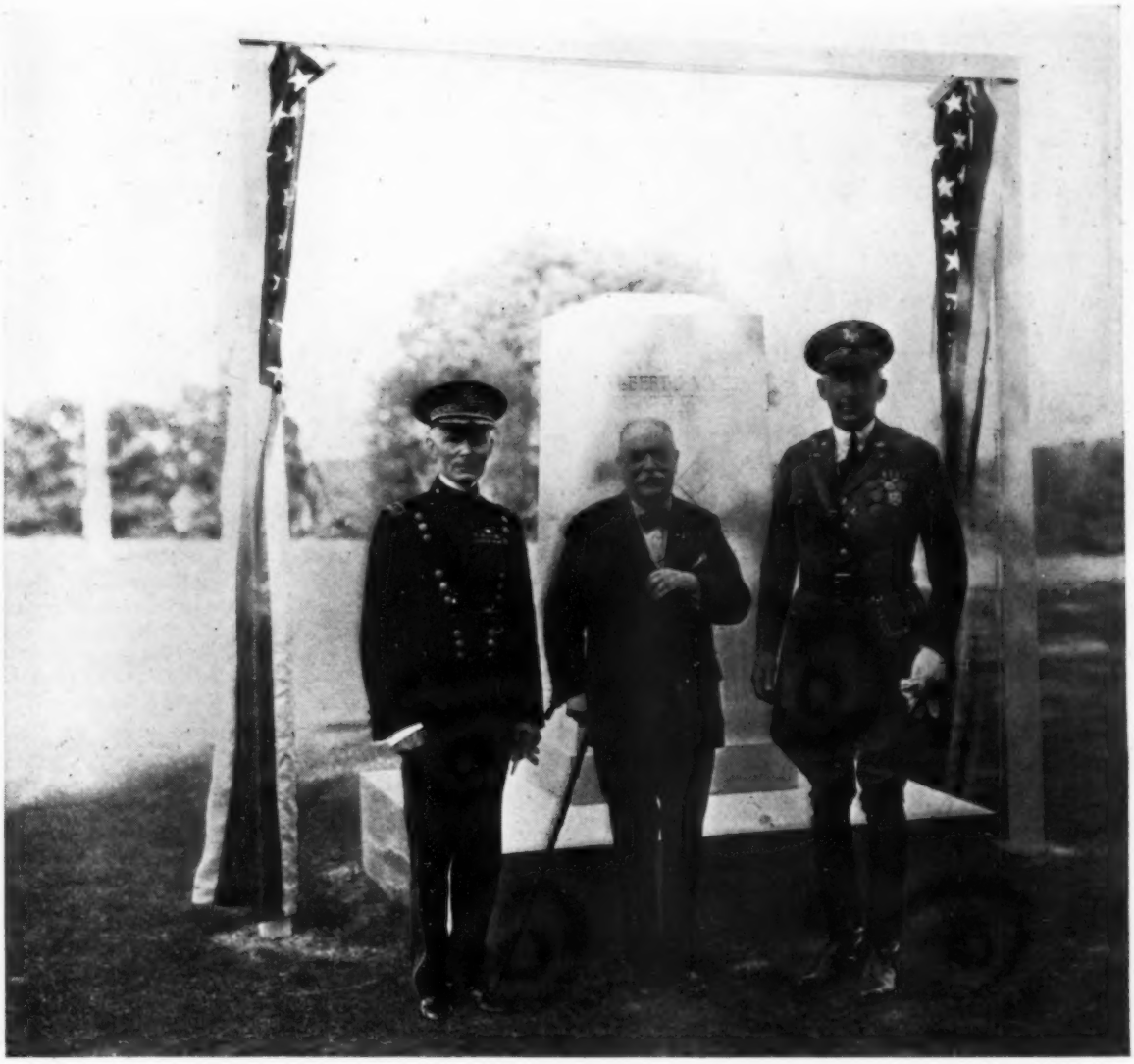
It is extremely important to us, however, to be ever mindful of the first part of the history of the Corps, for it was through the trials and accomplishments of those years that there came into being the tradition of gallant service, of constant readiness, of carefully nurtured technical skill, and of unremitting self-sacrifice in the defense and maintenance of free institutions that activates the Corps today. Powerful and ingenious as are the many rugged and versatile devices with which science and engineering have armed the men of the Corps, it is the devotion of those men—many of them recruited from the great communications industries of the nation and from the ranks of radio amateurs—that inspires and vitalizes the whole.

That tradition of devotion had its origin in the years just before the War between the States. The perfecting of a practical working telegraph by Samuel F. B. Morse in the middle 1830's gave impetus to thinking about methods of signaling on land—a matter which had lagged considerably in comparison with systems used at sea. Crude semaphores had been used in Europe in the Napoleonic era, a similar system had been employed by newspapers for a short time in this country, and of course the Indians of our Far West since before the coming of the white man had used smoke signals. Semaphores, however, aren't mobile, and smoke signals aren't flexible or dependable enough to meet military needs. Hence it remained for Albert James Myer, a young Army surgeon who was later to become the first Chief Signal Officer of the Army, to devise a system possessing the two prime requisites of mobility and reliability.

General Orders No. 17, dated July 2, 1860, contained an entry from which the Signal Corps of today has grown. It read: "Assistant Surgeon Albert J. Myer to be Signal Officer, with the rank of Major, June 27, 1860, to fill an original vacancy." Behind the creation of that original vacancy and the appointment of Major Myer to fill it lay a story of several years' patient work directed to the specific end of perfecting a system of signals, as well as a story of natural aptitude for and interest in the ways of transmitting intelligence.

Major Myer, born at Newburgh, New York, in 1827, had served an apprenticeship as a telegraph operator, and after graduating from Hobart College at Geneva, New York, in 1847 had studied medicine at Buffalo Medical College, receiving his degree in 1851 for a thesis entitled "A Sign Language for Deaf Mutes," which contained the nucleus of his system of visual signaling. The new doctor practiced medicine for three years and then was commissioned an assistant surgeon in the Regular Army and stationed in New Mexico. Here he devoted himself to the development of visual signaling with flags or lights, drawing up a memorandum on it in 1856. After investigation by an examining board named by the War Department, and after a considerable period of experimentation with flags, lamps, and glasses, the so-called "Wig-Wag" system was favorably reported to the Department. The act which authorized appointment of the first Signal Officer also carried an appropriation for the purchase of equipment, and thus the nucleus of the Signal Corps was established.

Hardly had Major Myer's work thus been given definite place in the military service of the country before it was called to face the test of war. In May, 1861, Major Myer was ordered to Army headquarters, and on June 10 a signal school was opened at Fortress Monroe, Virginia. As the War between the States wore on, Major Myer well exemplified the motto later to be adopted by the Corps: *"Pro Patria Vigilans"*; he was constantly on the alert for new methods and new ways to improve the signal work, advocating the formation of an independent corps to



Two former Chief Signal Officers, Maj. Gen. Geo. O. Squier, Retired, and Brig. Gen. Geo. P. Scriven, Retired, with Maj. Gen. Irving J. Carr (1932), before memorial to Brig. Gen. Albert J. Myer, First CSigO.

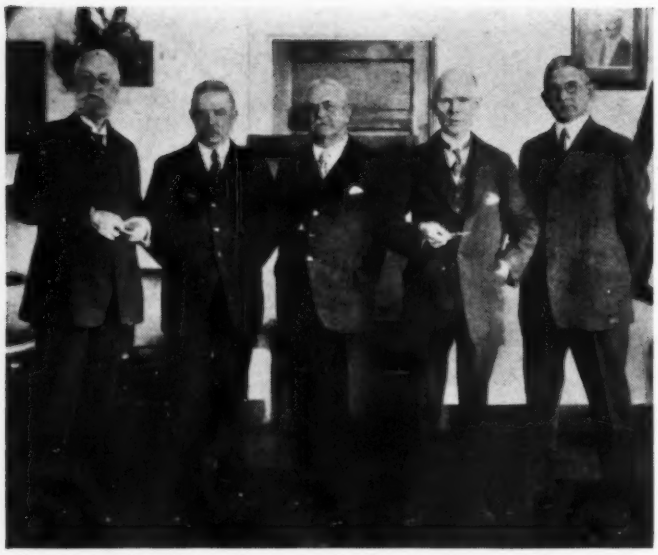
avoid the inadequacies of training by the detail system, working for the formation of regular telegraph field trains to move with the troops, bringing balloons into use as a means of gathering information, improving the cipher used for transmission of messages, developing signal schools for the continual instruction of operators, speeding the improvement of telegraphic communication to meet the rigorous demands imposed by swift service in the field. In his undiminishing efforts to take advantage of every developing means for communication, Major Myer foretold the attitude which the Signal Corps maintains to this day. It is noteworthy that his use of balloons in the 1860's was precursory of the development of military aviation in which the Corps was to play a leading role in the first World War, and his urging of the telegraph train anticipated the Corps' later work in the development of field radio. Adoption of the Myer code by the Union Navy in 1861 was a sign of the close relationship destined to exist between the United States Navy and the Signal Corps of the Army to this day.

It is impossible to detail the many interesting incidents in the history of "Signals" in this war. Work of signalmen was of central importance at the battle of Gettysburg, where Little Round Top was held for the Union forces through the activity of a signal station atop the hill. Army signal officers were aboard Farragut's ships at the Battle of Mobile Bay in 1864, and by their work drew from the Admiral after the engagement the statement that "it gives me great pleasure at all times to bear testimony to the efficiency of the Army Signal Corps, particularly to the skill and attention to duty of its members who have been stationed . . . under my immediate eye."

Of great importance as presaging the present day independent "going concern" which is the Signal Corps, was the Act of March 3, 1863, which provided for a separate Signal Corps for the duration of the war. And it is interesting that the crossed flags which are the present Corps' proud insignia were worn by Signal Corps men on their jacket sleeves at Nashville in March, 1862, more than eighty years ago.

In the years after the war, an assignment of far reaching importance came to the Signal Corps through a joint resolution of Congress approved February 9, 1870. This required the Secretary of War to provide for the taking of meteorological observations at military stations throughout the nation and for giving notice on the Great Lakes and the Coasts of the approach of storms. It was the first attempt to organize a weather service on a national scale, and it was a matter in which Albert J. Myer, now a colonel, had long been interested. A system of observer-sergeants was set in operation, and careful plans were made for the telegraphic transfer of data among stations and the assembly of all data in Washington. The first systematized synchronous reports were made by observer-sergeants at twenty-four stations in November of 1870. They were delivered in all eastern cities within an hour and a half.

In the next year, storm signals were displayed for the first time. That year saw the bringing into this work of a young second lieutenant, Adolphus W. Greely, of whom much more was to be heard in Signal Corps work in time to come. Older readers who remember newspaper satire



Left to right: Brig. Gens. A. W. Greely, James Allen, G. P. Scriven; Maj. Gens. G. O. Squier and C. McK. Salzman (1924).

directed at "Old Prob" the Weatherman may not know that this legendary figure took his name from the tri-daily "Synopsis and Probabilities" which the meteorological service of the Corps began to issue in the early 1870's.

By no means was weather observation the only work of the Corps during these years. As the westward expansion of the nation continued, greater and greater grew the need for swift communication among the farflung outposts. Construction of Signal Corps telegraph lines was started in Texas, Indian Territory, Arizona, and southern California. The Corps established the policy of linking up frontier posts and settlements by telegraph and discontinuing service as the commercial telegraph companies gradually extended their systems. About 1880, when this service was at its peak, more than 5,000 miles of telegraph line were being operated by the Corps, having been constructed and maintained by its own personnel. Construction of over 2,000 miles of this line in the late 1870's was directed by Lieut. Adolphus W. Greely.

Working out better ways of instructing personnel in the expanding duties of the Corps was another problem of these years. The instruction camp established at Fort Greble in the District of Columbia in 1868 was transferred in 1870 to Fort Whipple, Virginia, which later was named Fort Myer in honor of the "Father of the Corps." A thorough-going course in both theoretical and practical subjects was instituted here in the 1870's. Thus at the time of his death in 1880, Brigadier General Myer could look upon a Signal Corps, active in many different ways, with well planned training in progress looking toward the future.

Brigadier General William B. Hazen succeeded General Myer as Chief Signal Officer, which post he held for seven years. It was during his regime that men of the Signal Corps showed their mettle as Arctic explorers, in two expeditions which rank high in the annals of courageous scientific endeavor. As a result of international polar conferences held at Hamburg and Berne in 1879 and 1880, ten nations agreed to co-operate in polar expeditions for the taking of synchronous meteorological data for one year, beginning in August, 1882. The War Department was authorized by Congress to establish two stations, one at Point Barrow in Alaska, the other on Lady Franklin Bay, Grinnell Sound. The U. S. Coast and Geodetic Survey collaborated with the Signal Corps in the taking of magnetic, tidal, and pendulum observations, and naturalists of the Smithsonian Institution also participated in the undertaking.

The Point Barrow expedition, under the command of Lieut. Philip H. Ray, acting signal officer of the 8th Infantry, included ten persons. Leaving San Francisco on July 8, 1881, it was established September 8 at Point Barrow, the most northerly point of Alaska. From December, 1881, to July, 1883, hourly magnetic observations were taken. An important natural history collection was made, and in October, 1883, the entire party returned to the United States, not a man having been sick a single day during the expedition.

Serious encounters with ice hindered the other Signal Corps expedition when it set out from St. John's, Newfoundland, on July 6, 1881, under the command of Lieut. Adolphus W. Greely, Acting Signal Officer. Forcing a passage through the floes, the party reached its base on August 11. Supplies for two years were taken, and in addition to the regular meteorological and magnetic observations, valuable exploring trips were made by sledges and a Navy steam launch which had been brought along. Greely explored the interior of Grinnell Land. Lieut. Lockwood with a party of twelve men traveled the unexplored northern coast of Greenland, and reached a point farthest north at that time. The relief expedition which had been scheduled was unable to get through to the party, and hence cached food at points to the southward. A second relief expedition likewise ran into difficulty. Meanwhile Lieut. Greely followed the plan of conduct which had been set up at the start of the expedition, starting south at the prescribed time. Emergency quarters were established, and the party made out as well as it could with food recovered from caches, and living off the country. Another relief expedition which set sail on May 1, 1884, succeeded in reaching Cape Sabine on June 22, rescuing seven survivors, one of whom died on the home passage. Lieut. Greely brought back safely an unbroken series of meteorological, tidal, magnetic, and pendulum observations of great value to the international undertaking.

Development of the heliograph, with thirty-mile transmission at Fort Whipple, and experimental work with the telephone were the major activities of the Corps in the communications field during this period. Three heliograph detachments were sent to General Miles for use in the Indian campaigns in Arizona in 1885-86.

General Hazen died January 16, 1887, and one month later Adolphus W. Greely, then a Captain, was nominated to succeed him as Chief Signal Officer, with the rank of brigadier general.

At once General Greely set out to revive instruction and interest in military signaling and to improve field equipment. A new type of heliograph, weighing but fourteen pounds, packed, was designed, helio messages being exchanged up to a distance of 125 miles. Progress was made in the development of a field telephone kit, and a new field telegraph train was perfected with smaller, lighter wagons—mules still did the work which trucks do now. Lack of centralized training programs was emphasized as a hazard by General Greely. The school at Fort Myer had been closed in 1885 by direction of Congress.

The Signal Corps was reorganized in personnel and duties by the Act of October 1, 1890, which relieved it of non-military meteorological work. The Weather Bureau of the Department of Agriculture was charged with general weather studies. Meteorological instruments and methods especially adapted to securing ballistic data for artillery and small arms firing were subsequently developed by the Corps. Further experimental and developmental work was done with signal lanterns, balloons, pigeons, field telegraph lines, and field telegraph trains, and a school for the instruction of enlisted men of the Corps was opened at Fort Riley, Kansas, in 1891, to continue until after the Spanish War. The telephone of course was coming to the fore during this time as a means of swift communication, and the Corps kept pace with it. In 1892, for instance, of 92 garrisoned Army posts, 59 had been equipped with a telephone system.

Hence when the Spanish War broke out, the Signal Corps as a nuclear organization was ready for its swift temporary expansion to a total strength of more than thirteen hundred. Work on fire control systems which had been going on before the war began, stood the organization in good stead after hostilities commenced. Cutting enemy cable and laying American ones, establishing

(*Continued on page* 156)

U. S. ARMY
SIGNAL CORPS

Brig. General Albert J. Meyer, Chief Signal Officer, 1860-1880.

CHIEF SIGNAL OFFICERS

1860 — 1942

To "get the message through" has been the watchword of the Signal Corps. Under the inspired leadership of its Chief Signal Officers our communications systems are the best in the World and are fully capable in any emergency.

Maj. Gen. William Hazen, 1880-1887.

Brig. Gen. A. W. Greely, 1887-1906.

Brig. Gen. James Allen, 1906-1913.

Brig. Gen. G. P. Scriven, 1913-1917.

Maj. Gen. G. O. Squier, 1917-1924.

Maj. Gen. C. McK. Saltzman, 1924-1928.

Maj. Gen. George S. Gibbs, 1928-1931.

Maj. Gen. Irving J. Carr, 1931-1934.

Maj. Gen. J. B. Allison, 1935-1937.

Maj. Gen. J. O. Mauborgne, 1937-1941.

Maj. Gen. Dawson Olmstead, 1941.

Temporary field wireless telegraph autocar, Nov., 1904 (Maj. Gen. Arthur MacArthur era).

Early radio equipment being tested. This is one of the first types used by the Signal Corps prior to the first World War.

The "FIRST SIGNAL CORPS"

Our entire communications system has consistently met the challenge of our enemies and functions with precision and with traditional fortitude.

by Lieut. Col. C. J. McINTYRE

Born in Philadelphia in 1895. First commissioned as 2nd Lieut. in the Infantry of the Regular Army. In World War I, served with the 4th U. S. Infantry, and on return was in command of Co. I, 13th Infantry. Capt. of Infantry, 1920. Graduate of Fort Benning Company Commanders' course in 1921. Asst. G-3 of 91st Div. in California until resignation from the Regular Army October 31, 1922. Recalled to active service in the Infantry as a Reserve Officer on November 18, 1940. Transferred to the Office of the Chief Signal Officer on Sept. 17, 1941, and later was promoted to Lieut. Colonel in the spring of 1942.

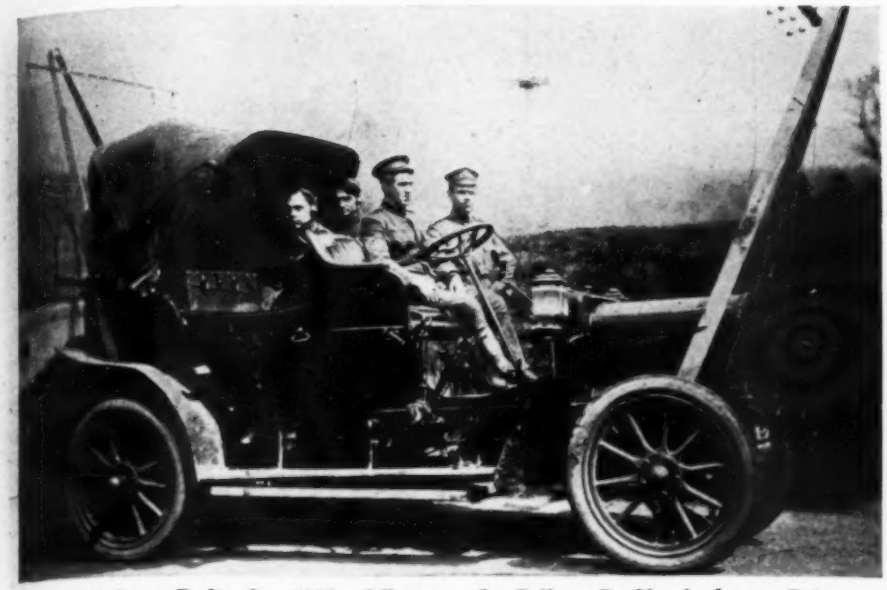
WHEN World War I for the first time plunged United States into a truly multilingual struggle on battle lines stretched out over much of the globe, the Signal Corps of the United States Army fortunately was ready and flexible enough to rise quickly to meet the unusual demands that were placed upon it. Such readiness and such flexibility don't just happen, and therefore it is worth while to look back a little to see why and how the Corps had in the years before 1916 developed the qualities which events proved to be essential. Even though, as you know, the history of the Corps is a long one, dating far before World War I, we can fairly call the Corps of 1916 the "first Signal Corps" in the modern sense.

Originating in the 1860's, taking stronger form in the Spanish War of '98, the Corps between that latter year and the grim spring of 1916 went through a sort of shakedown period. New duties were undertaken, research and investigation were pushed. Consequently, the Corps at the end of those eighteen years had added to the body of knowledge at its command, had gained further experience in its main job of being always ready and able to turn new methods, of whatever kind, to effective use in "getting the message through." It was in these years that the electron tube and the airplane—the two chief elements in modern war—came into major stature, and it was their arrival on the scene that truly gave the Signal Corps of 1916 its rightful claim to "firstness."

The story of how men of the Signal Corps kept abreast of developments in aviation and in radio is a long one, filled with multiple details, which deserves to be told by itself. Let us first take a look at some other activities of the Corps during this period—some of which might not at first thought, be counted as the kind of thing the Corps would be doing, but all of which were to stand it in good stead as experience imperative in getting the message through once World War I had broken out.

One big job which the Corps carried out during this period was the installation of an extensive system of military telegraph and cable lines in Alaska, where today the Corps is once more engaged as the military road is shoved northward. Forty and more years ago, under Major Frank Greene, first Signal Officer of the Alaska department, connection with the Canadian telegraphs was made on the Yukon between Fort Egbert and Dawson. That was in September, 1901. By July of the next year, six of the seven sections of land line had been completed, and in the following year, the whole job was finished, with a total mileage of 1740. The men of the Signal Corps performed this task under conditions of unusual difficulty. The temperature went to 72° below zero in the winter, and in the summer, hordes of mosquitoes drove the working parties nearly insane.

Once the land system had been completed—and every pound of material and equipment had to be moved in by pack animals at a rate of not more than fifteen miles a day—the job of keeping the lines open was no small one. Forest fires damaged lines. Food and supplies for at least a year in advance had to be forwarded to every telegraph



Signal Corps Radio Car, 1910. Officer was Lt. Pelham D. Glassford, now Brig. Gen., retired. Wood masts support antenna system. Equipment is in rear seat.

Field Artillery Telephone used by the Signal Corps in the year 1910.

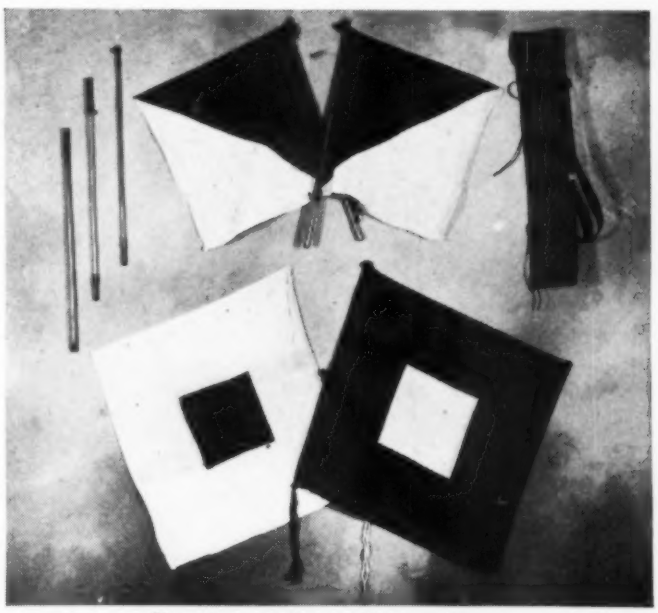
station. Repair parties of three men each were stationed in log cabins forty miles apart, rationed for a year. Improvements on each section were made yearly, and a new line was installed from Valdez to Fairbanks in 1908-9. These early workers on the job of getting the message through were supplied by dog teams; their successors look to the airplane instead.

The Alaska assignment called for underwater routes for intelligence, as well as those overland. This meant that the Signal Corps, which had earlier laid cable—for example, to connect Manila and ill-fated Cavite in 1898, and to link Siboney and Playa del Este in Cuba in that same year —had the chance to show its flexibility by laying underwater lines also in the north, where conditions were considerably different from those encountered in the semi-tropical regions which were the scene of the 1898 activities.

The longest cable ever manufactured in America prior to 1903 was the one which the Safety Insulated Wire and Cable Company of Bayonne, N. J., fabricated in that year for the Signal Corps to lay from Seattle, Washington, to Sitka. This being long before the days of the Panama Canal, the cable was brought around Cape Horn in the best traditions of the old sailing days, the first section being transported in the summer of 1903. The Coast and Geodetic Survey surveyed the route from Seattle to Sitka, and the job of actually laying the cable was in charge of Colonel James Allen, assisted by Captain Edgar Russel, who drew the specifications. The transport *Burnside,* which had been fitted out as a cable ship and used in the laying of cable in the Philippines in 1900 under Captain George O. Squier and Captain Russel, was the operating vessel in the Seattle-Sitka undertaking.

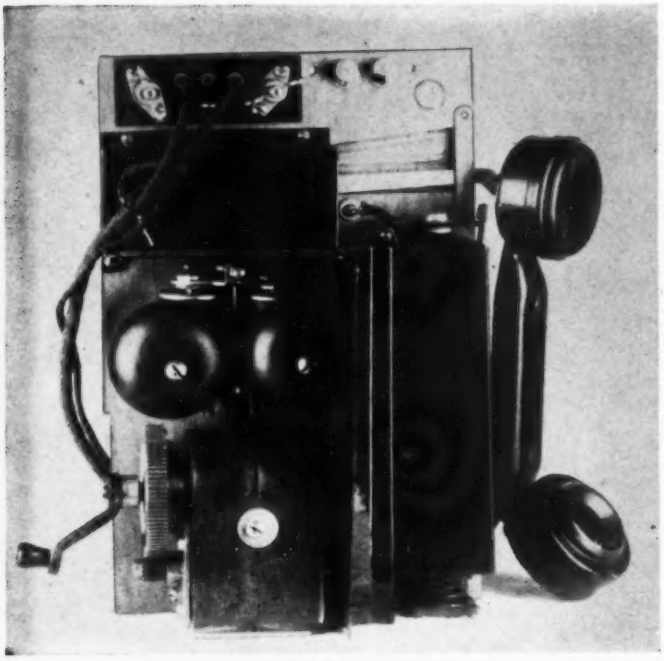
Laying was started in Alaska from the *Burnside* in the fall of 1903, Juneau and Sitka being connected and 600 miles of cable being laid at sea. During the winter, when the *Burnside* had to suspend operations for several months, the buoyed sea end of the cable was washed away, and so the whole 600-mile section had to be fished up out of the sea and put back into place. Nevertheless, the entire stretch of 1070 miles included in the Sitka-Seattle branch was completed by August, 1904. In the years thereafter, other sections were installed, necessary repairs and maintenance were done, and the Seattle-Sitka line was duplexed. Through this assignment, as through its earlier work in the Philippines, the Signal Corps built up a valuable stock of first-hand knowledge and experience of areas particularly important in the present war.

Speaking of the Philippines recalls two other highlights of this period of the Corps' career which are significant and interesting because they show the men of the Signal Corps in action in the field of war. Arduous duties

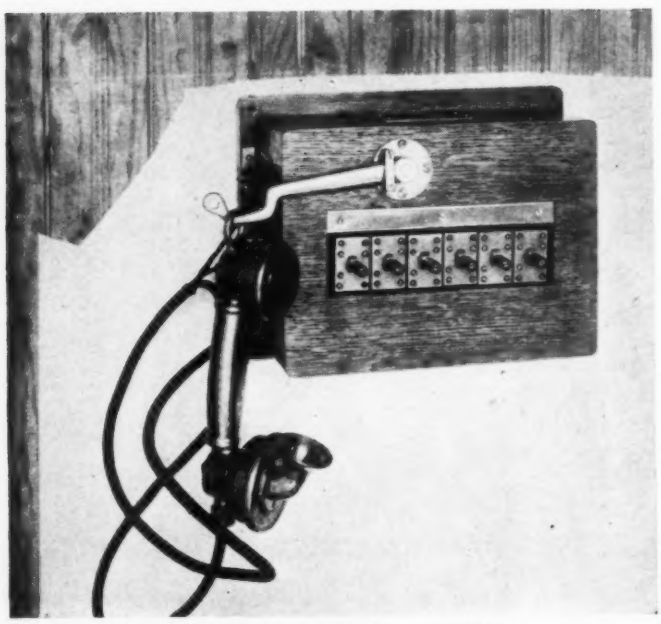


Kit of signal flags. The pouch was of canvas. Sticks were collapsible.

Operator at terminal station showing induction telegraph set back in 1913.



Early camp telephone interior shows the hand-cranked magneto assembly.



Signal Corps switch key set, 1912. French type handset was employed.

The U. S. Cavalry used this buzzer model field telephone in 1909.

in the field were performed by small detachments in 1899 upon the outbreak of the Philippine Insurrection. In that year, Signal Corps men were present in no less than sixty-one skirmishes or actions, maintaining electrical communication with flying columns and advanced posts. By June 30, 1900, 3475 miles of land lines and cables were being maintained and operated by the Signal Corps, sometimes under conditions of unusual difficulty. In one place, for instance, when the supply of wire had been depleted, the armor of river cable was stripped to provide forty miles of No. 21 copper wire, and thirty miles of this bare conductor were strung along the ground, buzzer communication thus being established. Field lines were often laid first on the ground, then strung on bamboo or soft wood poles, and then later replaced by permanent lines on hardwood poles.

Just as true today as when he said them are the wor of General Arthur MacArthur, then commanding t American forces in the islands as his son was later to d "As a means of tactical control, wire service in the han of trained, skillful and fearless men may be regarded a an indispensable adjunct of modern war, in which lig it is a great privilege to speak in behalf of the future d velopment of the Signal Corps in the regular establis ment to the full limit of essential military usefulness."

The year of 1900 was decidedly a year of action for th Signal Corps. While the men of the Signal Corps wer pretty well busied with the job of getting the messag through in the Philippines, the China Relief Expeditio called for a Signal Force to accompany the allied troop marching to the relief of the legations at Pekin. One of ficer and fifteen men were selected for this duty by Colone James Allen, Chief Signal Officer of the Philippine Divi sion. Material for a hundred miles of telegraph line wa provided, but many of the instruments and battery jar suffered badly in transport. A few men and wire enough for a hundred more miles went forward from San Fran cisco. By the time the allied forces were assembled a Tientsin, the signal detail had installed a line to that poin from Tongku on the coast.

As the ninety-mile march to the beleaguered legations a Pekin began, the American and British Signal detachmen pooled their resources for the tough job of keeping tele graphic communication abreast of the advancing forces. For the first eight of the ten days of marching, the lin kept up with the troops. Chinese and Russians made trou

Receiving wireless message from Yerba Buena Naval Station, 1904.

ble, cutting the line frequently. The heat was intense, several signalmen being overcome, and two native coolies dropping dead. But in spite of these hazards, the line reached Pekin within thirty hours after the city was occupied, and was for several days the only means of electrical communication with the outside world. By way of the Morse sounders and relays which were used most of the way and the buzzer and telephone which pieced out the rest of the distance, military, diplomatic, press, and private messages went out in English, French, German, and Italian. Chinese and Russian messages were sent in cipher. The Japanese telegraph line reached Pekin a week after the British-American, and the Russian arrived ten days after the Japanese.

This sort of work in areas of actual combat, plus active contributions to defense preparations in the installation of fire control systems for the Coast Artillery—work which the Signal Corps of Engineers took over in 1914—bulked large in the regular work of the Signal Corps from 1899 to 1916. But the steady performance of standard tasks employing well known techniques—vital though it is—will not properly safeguard a nation in days of swiftly growing scientific and engineering knowledge. Constant vigilance is the price of security, and constant vigilance means keeping awake to new developments as they occur, studying them, and figuring out the best and quickest way to put them to work. Hence among the most important activities of the Signal Corps during these seventeen years between wars were those dealing with the two greatest potential military developments of the period—wireless communication and air-borne travel. It was the Signal Corps' privilege to take the lead in bringing into the nation's defense these two products of science which in our days have come to rely so strongly on each other and in the opinion of many observers to dominate the waging of war.

The Signal Corps very early in its history had taken to the air. On the recommendation of Major Albert J. Myer, who may be regarded as the founder of the Signal Corps, a balloon had been bought and tested in Washington in June, 1861, and sent forward for the use of General McDowell's army. During 1862, valuable balloon observations were made in the Peninsula and Fredericksburg campaigns. Abandoned since the Civil War, the use of balloons was revived in the early nineties, and balloon observations

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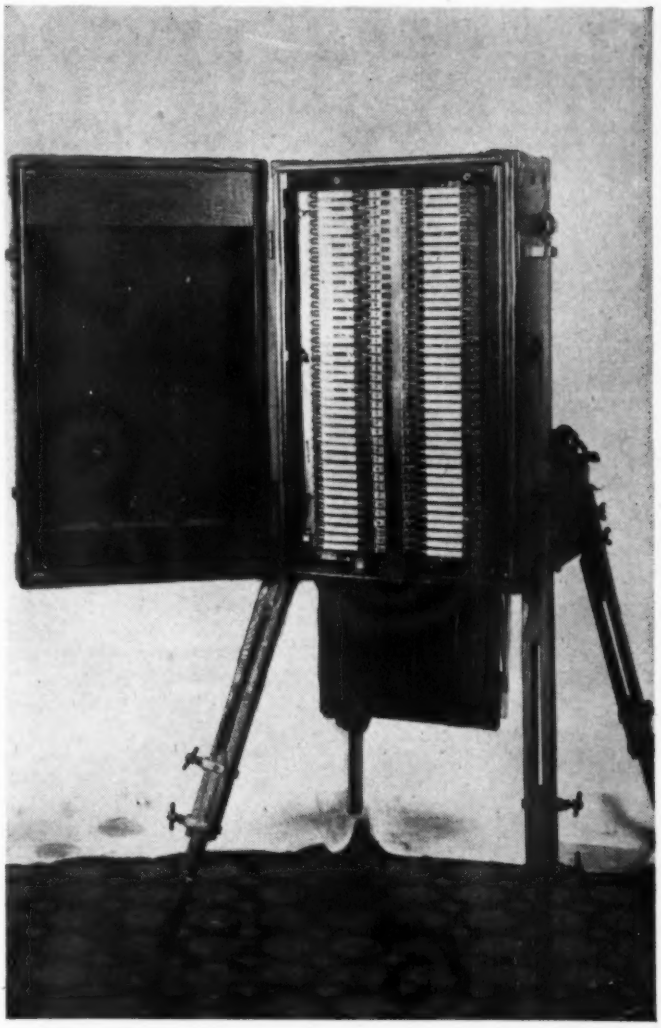


This camp telephone switchboard, used widely in 1915, is very crude compared to new equipment.

Playing out field wire from horse-drawn wirecart, 1913. Soldiers of the Cavalry rode behind to guide wire as it was fed from the preceding cart.

The Signal Corps in World War I

The personnel of the Signal Corps increased over thirty-four times its former strength after hostilities began in 1917.

Field radio set, Second Field Battalion, Signal Corps, Chaumont, France, April 11, 1918. Note the bamboo mast.

Using a 14 centimeter daylight signal lamp. 305th Inf., 77th Div., during World War I, Watta, France, May 18, 1918.

by Lieut. MILTON B. HERR

Born in Philadelphia, 1898. Attended Temple University. Served in the Marine Corps in World War I, having the distinction of being the only marine to be detailed for training at a Signal Corps School—the Signal Corps School of Photography at Columbia University in 1918. For several years following the war, edited "Telephone News," employee publication of the Bell Telephone Company of Pennsylvania. From 1924 to 1934, an officer in the Military Intelligence Division, Officers' Reserve Corps. Reentered the Signal Corps in July, 1942, as a First Lieutenant.

HOW greatly the job of defeating the Axis depends upon communications cannot yet be estimated, but it is a sure conclusion that the dependence will turn out to be very high indeed. As war has become more and more complex, the declarations of past Signal Officers have been borne out again and again, and there has been more general recognition that an army without its nerve centers is handicapped to the point of disaster. All we need do to support these statements is to look back to World War I—the first extremely complex war to be fought. In that war, which saw the Signal Corps increase to more than thirty-four times its number at the start of hostilities, the signal personnel required was about four per cent of total combat strength, a higher proportion of specialists in communications than had been seen before in the history of warfare. The great expansion of communications facilities which has taken place since November 11, 1918, and with which readers of RADIO NEWS are familiar, can safely be predicted to raise the ratio still farther.

When the United States entered the first World War, on April 6, 1917, the Signal Corps consisted of but 55 officers and 1,570 men. The commissioned personnel of the Corps at the time was secured mainly through the detail system, and the technical materiel available for field service was limited to a few types of apparatus designed chiefly for border and island warfare. Yet at the close of the seventeen months during which our country participated in the first World War, the expanded Signal Corps had strung more than 100,000 miles of wire in France, constructing 2,000 miles of pole line, installing some 40,000 miles of combat lines, operating 282 telephone exchanges and 133 complete telegraph stations, not including stations in the combat zone. Approximately 12,000,000 telegraph messages, 1,600,000 long-distance telephone calls, and 47,000,000 local calls were handled through this system in that period. The peak load of operation reached was 47,555 telegrams a day, averaging sixty words each. In July, 1918, the daily number of telegrams was half again as great as that carried on the British line, the messages individually running twice the length of the British on the average. When the Allied offensives began in that month, the expenditure of wire materiel was enormous. In the Meuse-Argonne offensive, twisted pair and field wire were called for at the rate of 2500 miles a week. Two armies, twelve corps and thirty-three divisions were completely equipped with field signal supplies.

Statistics don't constitute genuine history, but they do sharpen the historical past. How was it that the Signal Corps, small in numbers and scanty in materiel

Signal Squad, United States Marines and Alpine Chasseurs, with projectors at training camp. Note signaling flags.

in April, 1917, was able to hang up by November 11, 1918, such a record of accomplishment as the foregoing figures suggest? The answer is outlined in this appraisal of the Corps' World War record, which comes from General Pershing himself, who wrote after the Armistice:

"Now that active operations have ceased, I desire to congratulate the officers and men of the Signal Corps in France on their work, which stands out as one of the great accomplishments of the American Expeditionary Forces—the result of a happy combination of wise planning and bold execution with the splended technical qualities of thousands of men from the great commercial telephone, telegraph, and electrical enterprises of America. It is a striking example of the wisdom of placing highly skilled, technical men in the places where their experience and skill will count the most.

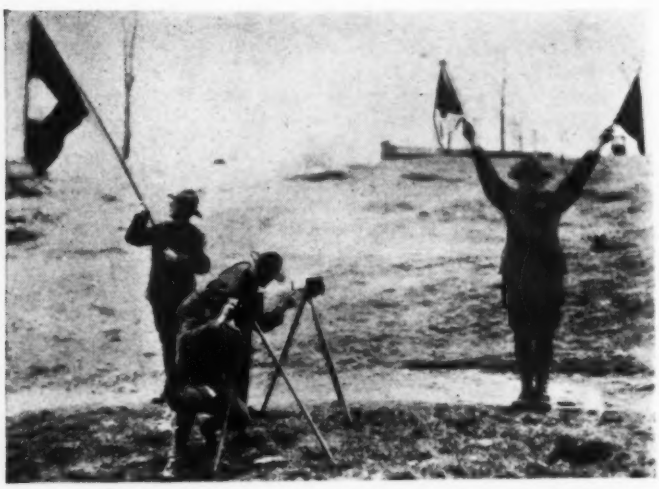
"Each army, corps, and division has had its full quota of field signal battalions, which in spite of serious losses in battle, accomplished their work, and it is not too much to say that without their faithful and brilliant efforts and the communications which they installed, operated and maintained, the successes of our Armies would not have been achieved.

"While the able management of the directing personnel is recognized, it is my desire that all members of the Signal Corps, who, regardless of long hours and trying conditions of service, have operated and maintained the lines, shall know that their loyalty, faithfulness and painstaking care has been known and appreciated. In the name of the American Expeditionary Forces, I thank them one and all, and send to them the appreciation of their comrades in arms and their commander-in-chief."

It was the co-operation of the great American communications industry plus the harmonious relationships between regular Signal Corps officers and those commissioned from industry which produced swiftness and smoothness in the planning and execution of the signals program

Members of the 6th Brigade projector unit signaling from tree outpost. Andernach, Germany, May 30, 1919.

Signaling by flare, Saulty, France, August 11, 1918. Pistols in rear shoot fire stars of various colors as signals.



Signal Corps activities—wigwag, heliograph and semaphore were used commonly during the early days of the holocaust.

★ ★ ★

The Papham panel system of visual aeroplane signaling. The white letter T is an all-clear signal, ending message.

required by the war. The scope of that program has already been suggested; more will be said of it later. It was the skill and devotion to duty of the myriad technicians who strung the lines in France and ran the exchanges and did all the other tasks needed to get the message through under fire that assured thoroughness and efficiency in the operation of the program.

World War I, like the present conflict, posed special problems to the armies of the United States because of the wide range of the world involved in the fighting, and the consequent necessity of establishing training systems at home for troops later to be sent abroad. To the Signal Corps in 1917-18, this problem was of special importance, in view of the Corps' duty to provide communication facilities for the rapidly expanding army camps in the United States proper, while at the same time it was assembling men and supplies both for behind-the-lines installations in France and for Signal Corps combat battalions who carried communications into the front lines. Large numbers of skilled personnel came into the Corps from the communications companies—the American Telephone and Telegraph Company, Western Electric Company, Western Union and Postal Telegraph companies. In addition, large numbers of untrained but selected men had to be taught the techniques needed. Consequently, a comprehensive training program was instituted in the mobilization camps.

In France, where Colonel (later Major General) Edgar Russel served as Chief Signal Officer of the A.E.F., a program similarly was inaugurated for training for combat duty. Research continued on both sides of the water, the development of land and airplane radio equipment being one of the main centers of study. The most important problem was the design of suitable vacuum tubes. In April, 1917, the Allies were using such tubes for various signal purposes, but in America only limited use had been made of them. At the close of the war, however, American tubes were being employed for detection, radio and audio frequency amplification, continuous wave transmission, voice modulation, voltage and current regulation on generators, and other purposes.

The permanent telephone and telegraph wire systems installed by the Corps ran clear across France from Brest to the Luxembourg border, and crossed that country as well. Bordeaux, Paris and the A.E.F. general headquarters at Chaumont, were key points in the system. Vacuum tube repeaters, still new in American practice, were used instead of loading coils, and they made clear telephone conversation possible between Paris and Chaumont. The Corps was charged with the responsibility of installing telephone and telegraph lines and offices and supplying the necessary personnel for the operation of train dispatching and signal systems.

The radio division of the office of the Chief Signal Officer, A.E.F., organized in October, 1917, had three functions—procurement, organization, and instruction of the many radio specialists needed; procurement and inspection of radio materiel and necessary research; assignment and supervision of special radio field units. Interception of enemy radio messages in April and June, 1918, gave information of raids which were in prospect, and made it possible to warn the troops concerned in time for them to make proper dispositions. During the Meuse-Argonne offensive, the radio division established a false army radio net on the Beaumont-Fresnes front. Over this false net, messages which indicated a general offensive on that front were sent in a cipher which the enemy would be sure to untangle from apparent carelessness in the way it was being used. In addition, telephone lines were established along this front in such a fashion that the enemy could intercept conversations that sounded like a coming offensive.

The Germans fell nicely into the trap, and held two whole divisions in reserve at Metz because of fear of an attack east of the Meuse. A gauge of how radio has developed in the last twenty-odd years is to be had from the fact that in World War I the use of radio was in general subject to frequent interruptions and suspension of service. The apparatus was often damaged in transportation, and great difficulty was experienced in maintaining the supply of storage batteries. Radio then worked

This photograph, taken back in 1918, shows a group of soldiers practicing with Semaphore and Wigwag. These tactics are still employed for certain applications.

better from division headquarters to the rear than within the division. Out of the difficulties then met and studied, has come the growth which makes radio today one of the strongest weapons in the Signal Corps' arsenal. Radio really received its baptism of fire in World War I, and reaches its majority in the present struggle.

World War I also saw the beginning of a pigeon service in the American Army. Experiments with pigeons as message carriers on the Mexican border had not been successful, because of the inexperience of the personnel. The Chief Signal Officer, A.E.F., recommended the establishment of a pigeon service as a branch of the Signal Corps in July, 1917. Special training was of course necessary, and so the help of racing pigeon associations in the United States was invoked. At the time of the St. Mihiel offensive, 576 birds were distributed from thirteen different lofts to infantry and tanks. Ninety messages of military value were transmitted by pigeon, in spite of bad weather conditions. In the Meuse-Argonne offensive, 442 American birds were used. About 400 messages were delivered. In the inauguration of this little known service, the aid of amateurs was thus of great importance. The pigeon racing associations were able to supply instructors at a crucial time; just as the American radio amateur pitched in to help in World War I, when some 3,500 hams worked with the Signal Corps.

Another way in which World War I gave the Signal Corps a start on its responsibilities in the present war was in the development of ways of radio communication from a moving tank. Study of the French and British ideas of how to go about this problem was first made, and neither the French nor British scheme was judged satisfactory. Hence experimental work was started, and in due course the general specifications for a tank radio set were worked out. While steps were taken toward getting the set in production in the United States, research continued in France. Refinements were thus worked out, and a model set was shipped to the United States under the first available convoy. Three sets were built for trial under actual battle conditions, but the Armistice was signed before the tests could be made. In maneuvers in early December, 1918, however, the radio tanks got their trial, and extremely gratifying results were obtained. The importance of radio communication for the correlated use of tanks in modern warfare offers justification for the work of these earlier Signal Corps investigators, whether their tank radio got a chance in actual battle or not.

(*Continued on page* 152)

Intercept Station No. 1, operated by Radio Section, Signal Corps, at Headquarters Second French Army, June 18, 1918.

Flashlight Signal Station of the 128th Infantry, 32nd Division, at Austerlitz, Alsace, Germany, June 5th, 1918.

ORGANIZATION

The Signal Corps' place in our military machine

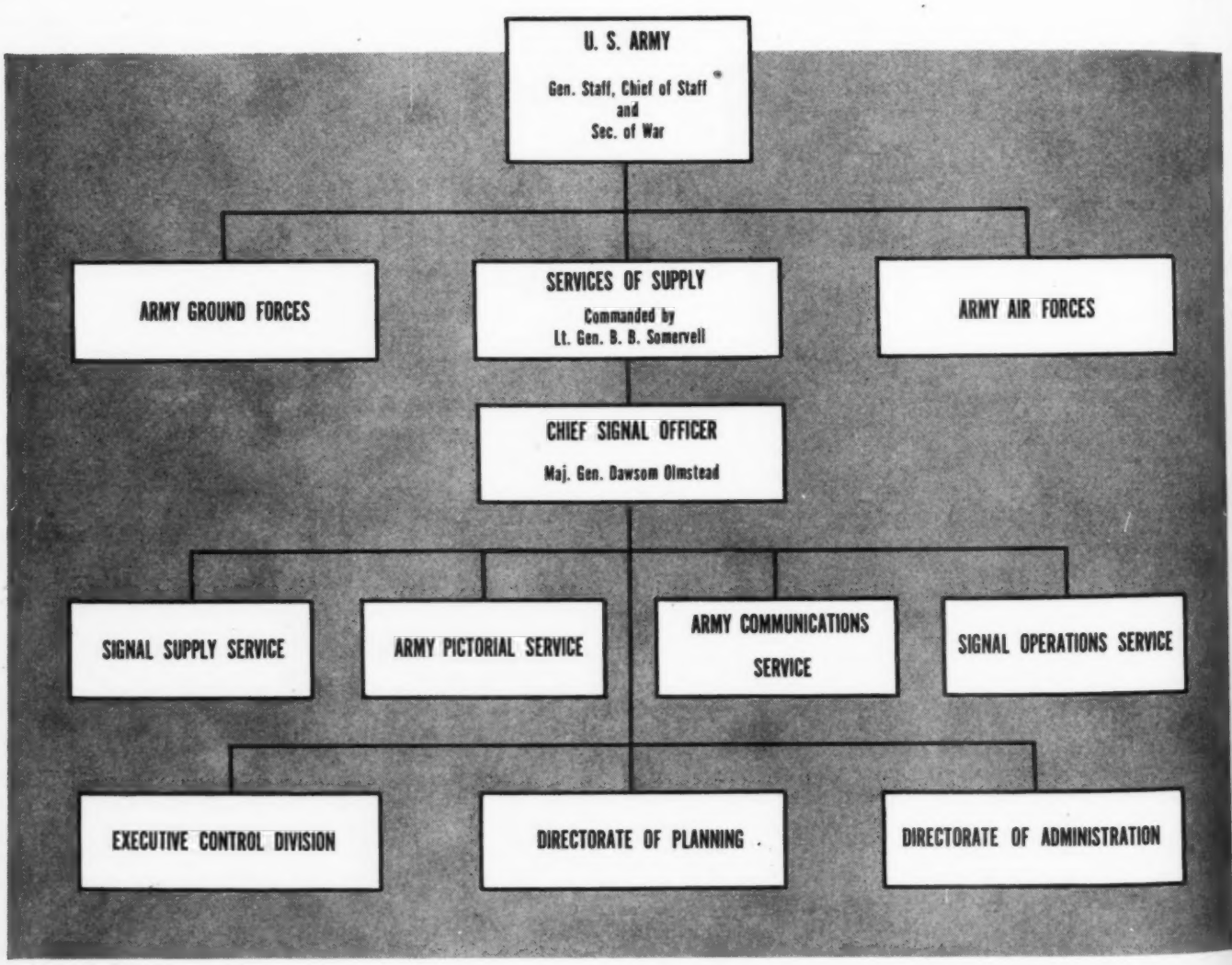
THE Army, better to meet the heavy duties imposed by global war, was in March reorganized on a functional basis, with three units—the Army Ground Forces, the Army Air Forces, and the Services of Supply—operating under the General Staff, Chief of Staff, and Secretary of War. Each of the three units is in turn organized in an efficient fashion worked out by careful planning. The Signal Corps is part of the Services of Supply, under the command of Lieutenant General Brehon B. Somervell.

As established by Major General Dawson Olmstead, Chief Signal Officer, the organization of the Signal Corps is a structure corresponding closely to the work which the Signal Corps has to do. The four Services—the Signal Supply Service, the Army Pictorial Service, the Army Communications Service, and the Signal Operations Service—are functional units responsible for the performance of the Signal Corps' various assignments of developing and procuring communications equipment for the Army, producing pictorial history and teaching films, maintaining communications among Army establishments, and getting the message through in scenes of actual combat.

For the efficient administration of the complex job, the Executive Control Division, the Communications Coordination Division, the Directorate of Planning, and the Directorate of Administration have been constituted. The Communications Coordination Division keeps the Corps abreast of commercial developments and looks after the problem of proper liaison with other services utilizing communications equipment. The four Services are divided into twelve operating Divisions, and the operating Divisions themselves fan out into numerous branches.

In the field, the Signal Corps is responsible for the installation and operation of communications equipment down to and including the regimental echelon and laterally to adjacent units of the same echelon. Forward or assault units use equipment operated by their own personnel, but procured by the Signal Corps. To each division is attached a division signal company. An Army corps or an armored corps includes a signal battalion.

A field army is allotted a headquarters signal service company, a construction battalion, an operations battalion, a radio intelligence company, a depot company, a repair company, a pigeon company, and a photographic company. In addition to these Signal Corps units, a field army usually has additional Signal troops of these categories in a GHQ reserve from which they may be drawn by the army requiring their services.



THE SIGNAL CORPS BETWEEN TWO WARS

The adoption of new techniques made it necessary to develop new and radically different radio and other equipment after the Armistice was signed in World War I.

SIGNAL CORPS BETWEEN TWO WARS

Photo taken during production of Training Film Project, Anti-aircraft 37mm. gun crew. Note telephone.

The vacuum tube has been a contributing factor in the development of equipment—the world's finest—for our Signal Corps.

by Lieut. Col. ROBERT E. MEEDS

Born in Washington, D. C., in 1899. Enlisted in Aviation Section, Signal Corps in January, 1918. Transferred later to the Tank Corps, and went to England and France. Returned to the United States in 1919. Attended Carnegie Institute of Technology in Pittsburgh and George Washington University, Washington. In 1923, entered Government service with the U. S. Tariff Commission and later with the Treasury Department. Appointed Second Lieut., Officers Reserve Corps, in 1928. Called to active duty in October, 1940, in the office of the Chief Signal Officer, Wash., D. C.

BETWEEN November 11, 1918, and December 7, 1941, the Signal Corps in many different ways made use of the lessons of World War I in anticipating the demands now being placed upon it by World War II. The first World War demonstrated beyond the shadow of a doubt the essentiality of the work with which the Signal Corps is charged. The reliance of armies in the Twentieth Century upon swift and dependable communication, emphasized and re-emphasized by the refinement of the electron tube and its applications during the past two decades, is perhaps the most salient fact in the military art as we now know it. One department of the Signal Corps' responsibilities in the first World War was brought during that war to such a degree of importance that at the close of hostilities it was given independent status; this was aviation. The airplane, which had been made a part of America's military strength through work of the Signal Corps dating back into the nineties and for which the Signal Corps had retained responsibility through the war, had by 1918 attained its majority, which was officially recognized in the establishment of the Air Corps in May, 1918.

Of the activities carried on by Signal Corps men between the two wars, those having to do with radio communication will in the light of World War II probably be judged of primary importance. The vacuum tube and the radio wave are instrumentalities of great versatility and great potency. They can be put to use for military purposes in innumerable ways. Without them, close collaboration between air forces and ground troops becomes well-nigh impossible. Without them, the firm co-ordination of movement and operation of the "panzer" division cannot be secured. Without them, the quick defense of cities and industrial areas against enemy air raiders is immensely handicapped. Obviously, the work of the Signal Corps in keeping American military art fully abreast of the rapid growth of radio in all the meanings of the term was fundamentally important to the present war effort.

The maintenance of close liaison with the communica-

Semaphore and wigwag were not discontinued after World War I. These are still used for short range communications today.

Closeup view of twelve-line field type switchboard. The instrument mounted on the tree is wire chief's testing set.

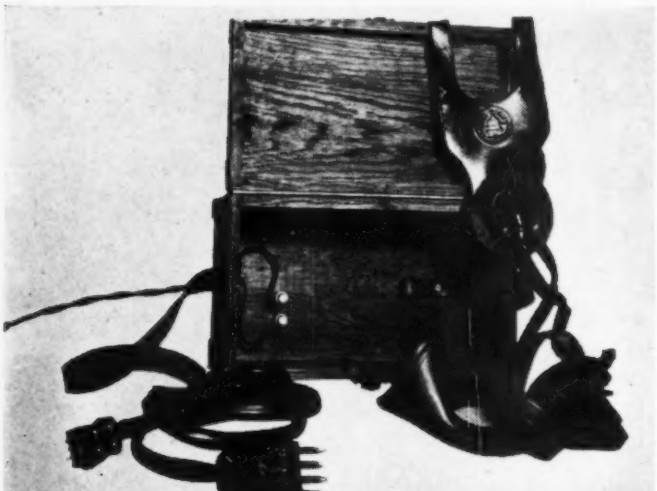
tions industry, with the manufacturers of radio materials, and with educational and industrial laboratories where basic radio research was being pushed was an extremely necessary part of this work. The cordial relationships which World War I had fostered between the Signal Corps and these various agencies were extended during the post-war period through the assignment of selected reserve officers to procurement planning in the Signal supply service. The Signal Corps' own laboratories at Fort Monmouth, New Jersey, had their origin in the late fall of 1917, and at that time were concerned with the development of radio. During the years between the wars, these laboratories were engaged in numerous development programs designed to assist in meeting the great demand which came from all branches of the Army for the quantity production of new types of equipment embodying the latest advances in communications engineering. The Signal Corps Aircraft Radio Laboratory at Wright Field, Dayton, Ohio, was similarly active. The close association of the laboratories with industry during times of peace stood both parties in good stead when World War II required the instant expansion of facilities.

Concrete illustration of the way in which radio came to dominate much of the Signal Corps communications picture in the period between wars is not hard to find. More than forty years ago, the Signal Corps had been charged with the responsibility of establishing an extensive system of military telegraph and cable lines in Alaska, and between 1900 and 1903 had completed the land project. In the latter year, two radio stations providing transmission across Norton Sound were established by the Signal Corps. This beginning was to see great growth in the years after the first World War. The Washington-Alaska cable which the Signal Corps had installed in 1903-4

A small radio-controlled glider was developed for target purposes during the period between the two world wars.

The target plane is transported from place to place by special truck provided with a cradle to hold the model.

Many new types of telephone equipment such as these field sets were developed after 1919.



This anti-aircraft altitude set was used in 1918. Photograph was taken at Paris, France, on October 10, 1918.

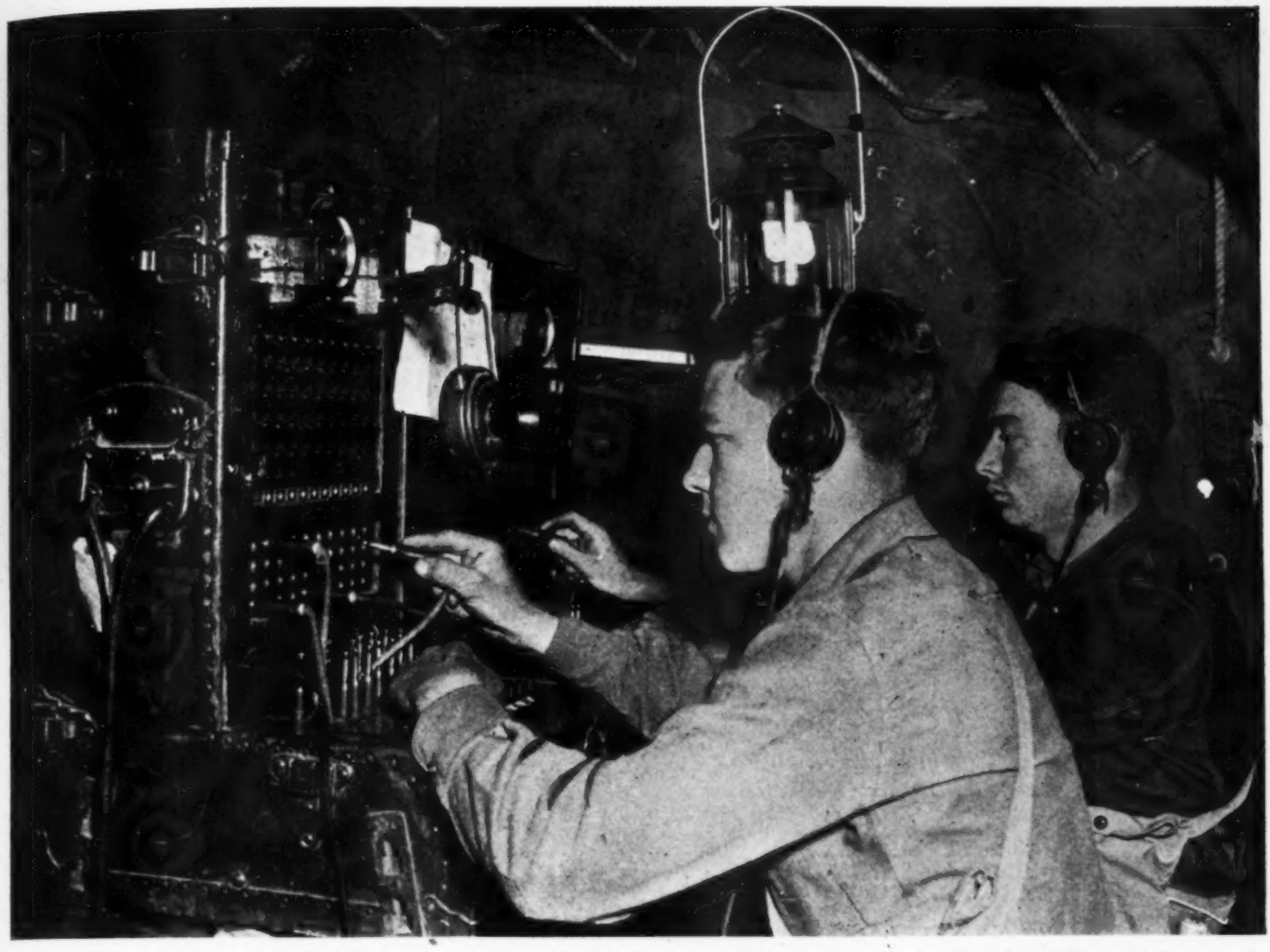
Another old timer was the General Electric Signal lamp which was used by the Signal Corps during World War I.

was replaced in 1932-4, gutta percha insulation being used in preference to the rubber insulation of the earlier cable. In addition to its submarine cables, the Signal Corps in 1925 was operating in the Alaska communications system 840 miles of land telegraph line with 44 offices, and 20 radio stations. Just three years later, the Corps discontinued its land wire communications, thus having in operation in 1928 cable stations, combination cable-radio stations, and radio stations. A land telegraph line was maintained between Fairbanks and Seward by the Alaskan Railroad Company. The next step was to establish a system for the transmission of messages via radio along the routes previously served by the submarine cable. This system was started in 1930, when an appropriation of $200,000 was made for the purchase of radio equipment to replace the cable system, and was completed by the fall of 1931. Since that time, the cable has been used only in emergency to augment the radio channels.

The scope of this system during the period between wars is well summarized in these words from the report of the then Chief Signal Officer, Major General George S. Gibbs, for the fiscal year of 1928: "The Washington-Alaska Military Cable and Telegraph System has shown a remarkable increase in traffic handled in the past year, considering the fact that there has been no increase in the population of the Territory. It is evidence of the increasing dependency of the population upon the Signal Corps communication system for its social and commercial existence. It also indicates the growth and stabilization of certain industries, especially the fishing and canning industries in southeastern Alaska. Thirteen newspapers, including seven dailies, are published in Alaska, and every word of press dispatch news from the outside world comes to them over the Signal Corps system."

Another gauge of the extent of the Signal Corps' Alaskan communications duties appears in figures showing the volume of traffic handled by the system in the fifteen years from 1919 to 1933 inclusive. In that time, messages of all classes totaled 4,143,119, and the value of total traffic reached the sum of $7,714,913.76.

However, establishment of the newest ways to get the message through was not restricted to Alaska during the between-wars period. This span of the Signal Corps' history saw the inauguration of the War Department Message Center and the War Department Radio Net—the nerve center of the vast Army communication system covering the United States, Alaska, and Puerto Rico, and extending to Hawaii, the Philippines, the Panama Canal



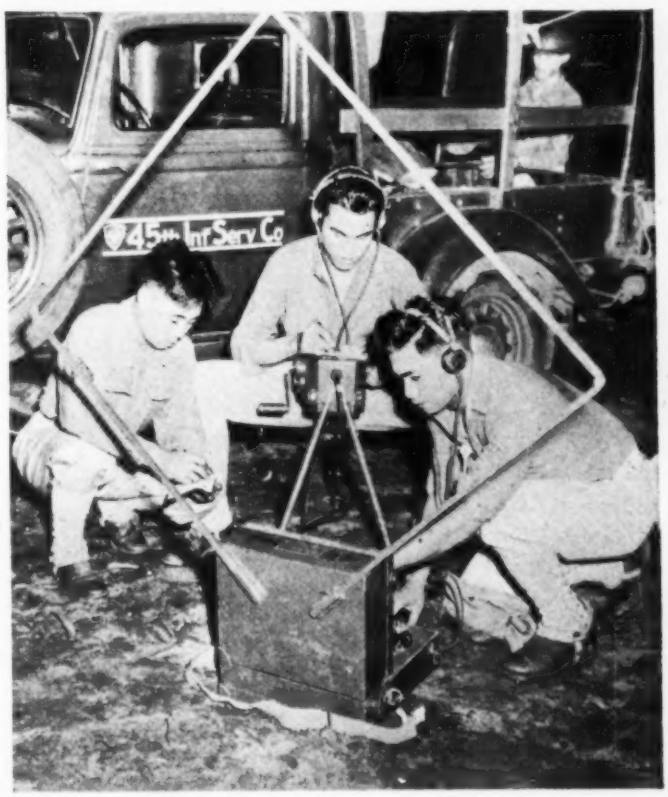
These men are operating a telephone switchboard installed in a truck during maneuvers prior to hostilities in 1941.

Zone, and now to the leased bases in Greenland, Iceland, Bermuda, and the West Indies. Radio is the principal means of communication used in this Net, supplemented by cable, telephone, telegraph, and messenger. The most modern wire and radio facilities of the communication art are employed.

Radio-telegraph stations were installed in 1921 by the members of the present Service Command headquarters, with the master, or net control station in Washington. Smaller stations in addition were set up at many military posts and camps. From 72 radio stations at the close of 1922, the network had grown to include 212 by 1929. As World War II got under way, the list had increased to over 300. The War Department Message Center itself was established as a part of the Office of the Chief Signal Officer on March 23, 1923. The official business of the War Department and a considerable amount of other traffic from other government agencies are cleared through the Center and travel by way of this Net. The history of the development and refinement of radio during the past twenty years was faithfully reflected in the series of improvements and additions made to the facilities of the Message Center and the Radio Net by the Signal Corps during the period between wars.

For a long time in its early history, the Signal Corps carried the whole task of supplying to the country information relative to the weather. The non-military part of this job was turned over to the Weather Bureau of the Department of Agriculture under the provisions of the Act of October 1, 1890. The Signal Corps thereafter was concerned with meteorology, only from the military point of view. The development of the airplane as an instrument of war vastly increased the importance of meteorological information during World War I, so that at the close of that struggle the Signal Corps had developed

This type of field set was developed and used widely in the past few years. Filipinos try out the radio equipment.



Lucas lamp and projector, used widely in the first war. Newer methods of communications are vastly superior.

Late model field set is capable of wide range. New circuits and tubes reduce weight and increase efficiency.

further techniques and abilities than those required for the securing of data useful in regulating gunfire. The Signal Corps is of course strategically organized to carry on the meteorological work of the Army, for it has the requisite close connection with means of swift communication. The special requirements of the Air Corps and other branches of the Army for more detailed meteorological information than are furnished by the Weather Bureau led to the Signal Corps continuing its operation of meteorological service after World War I was over. During this period, the Signal Corps was able to contribute to the success of several important aeronautical undertakings, including the round-the-world flight of Army aviators, by supplying special meteorological information. All important Air Corps maneuvers had a Signal Corps officer specially assigned as meteorological officer.

The use of carrier pigeons, which the Signal Corps had adopted in France during the first World War, was further developed in the years after that war. The Osman collection of homing pigeons was purchased and imported from England in 1919, pigeon lofts being established in several corps areas, as well as in the over-seas departments. Six years later, the Thomas Ross strain of pigeons was introduced. Breeding and training lofts were established during this period at Fort Monmouth, New Jersey, where the Signal Corps activities, with this means of getting the message through, have since been centered. Fanciers throughout the United States recognize the Signal Corps pigeons as a standard. Flying lofts are located at various posts in the United States and in outlying possessions. During the years between-wars, much training and experimentation were carried on by the pigeon branch of the Signal Corps, including the rapid settling of pigeons in new locations, improved and safer methods of releasing pigeons from airplanes, continuous flights, night flights, and trial flights over water from ships and islands. Distances as great as 110 miles were reached in some of these latter flights.

Photography, which had been included in the course of study in the Signal Corps School long before the outbreak of World War I, was assigned to the Signal Corps as one of its duties during that war. Fifty-four officers and four hundred and eighteen men composed the photographic personnel in France. Field photography was divided into ground and aerial activities. With the reorganization of the Army at the end of the war and the establishment of the Air Corps, aerial photography and ground photography pertaining to aviation were transferred to the new service. Maintenance of historical files of still and motion pictures, production of training films, and performance of ground photographic work not specifically assigned to other services were the work of the Signal Corps during the years from World War I to World War II. In 1925, responsibility for conducting the pictorial publicity activities of the Army was assigned to the Signal Corps. The Signal Corps Pictorial Service was established as a consequence, with the purpose of promoting desirable publicity through all photographic mediums. It was consistently active during the period under review. For six years in the middle of this period, a photographic course was added to the curriculum of the Signal Corps School in order to train enlisted men for service in the photographic laboratories. After an adequate reserve of enlisted photographers had been trained, the course was discontinued. The production of training films was pushed during this period, for all arms of the service, and as improved techniques developed they were of course used, sound films going into production very early.

The interval between World Wars had begun with special difficulties for the Signal Corps, which however troublesome they may have been, spoke well for the duties with which the Signal Corps is charged. The demand for telephone and other signal services in France did not diminish at a rate at all proportional to the decrease in military personnel, so that at a time when personnel changes were frequent the Signal Corps carried an extra load of work. The war stock which the Signal Corps accumulated had to be liquidated in the early part of the period. All signal installations and some movable equipment were sold to France. The special cable which had been laid across the British Channel was sold by contract, to Great Britain and France. The activities of the Signal Corps in France were not finished until early in 1920, and some Signal Corps troops remained on the Rhine until the evacuation of the Coblenz area by the Americans early in 1923. The authorized strength of the Signal Corps fluctuated somewhat between 1918 and 1941, being reduced in 1921 and again in 1928, but increased in 1934. Establishment of Fort Monmouth (formerly Camp Alfred Vail) as a permanent post in 1925 and the consolidation of the various training courses which had earlier been instituted there marked the between-wars period as of especial importance in the history of the Signal Corps as an educational agency.

In no small measure, because of the careful work done by farsighted members of the Signal Corps in effecting training plans during peacetime, the men of the Signal Corps found themselves prepared for the tremendous tasks with which they were confronted as a result of the beginning of war in December, 1941.

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The NEW SIGNAL CORPS

Their job is getting the message thru swiftly and accurately to all fronts.

THE NEW SIGNAL CORPS

The Signal Corps has expanded and adjusted itself to cope with changing demands and latest technique.

by Brig. Gen. JAMES A. CODE, JR.

Born in California in 1893. Graduated from the U. S. Military Academy in 1917. First service was with the Artillery, as Major (temporary) in 1918, reverting to permanent rank of Captain in 1920. Promoted to Major in 1932; to Lieut. Col. in 1940; Colonel in 1941; and Brig. General, 1942. Transferred to the Signal Corps in 1923, has held numerous posts, including duty at Ft. Santiago, Manila, P. I., and in the Panama Canal Zone. Assigned to the Office of the Chief Signal Officer at Washington in 1941 and became Assistant and Deputy Chief Signal Officer in the next year.

Students learn to operate field radio equipment under supervision of thoroughly-trained instructors.

Compact, self-powered field set is operated by this two-man team. This set uses a square loop antenna.

Another location for a field set. The man in the rear is operating a hand-driven generator (power source).

IN modern war, firepower, transportation, and communications hold the secret of success and victory. Without firepower, obviously, the enemy cannot be crushed in combat; without transportation, firepower cannot be brought to bear at the strategic point; and without communications, the guns, ammunition and troops that constitute firepower can neither be directed to the strategic point at the crucial moment, nor can they strike with full impact once they are there.

The Signal Corps is responsible for the effectiveness of all communications of the Army, whether the message is from a Field Artillery observation post to its battery, or from a fighter pilot over the South Pacific to another pilot in the same formation, or from the Chief of Staff in Washington to the Commanding General of the European Theatre of Operations. It is the unifying agency, developing and procuring the equipment, prescribing the tactics and the techniques of its use, and acting as advisor and consultant on all phases of communications to all commanders through all echelons of command.

It is difficult for a single mind to encompass even in broadest outline the magnitude of these functions in the war we are engaged in. To do so, it is essential to realize what makes this war different, in a military sense, from other wars.

The first difference is its global nature. There has been action on almost every meridian of longitude and every degree of latitude, extending even into the Arctic Circle.

The second is the intensity of fighting wherever man, either with or without artificial aid, can breathe—from the depths of the sea to the heights of the substratosphere; in deserts, swamps, jungles and mountains.

The third difference is the incredible speed of modern tactics. When the bulk of armies moved on foot, they marched, normally, at a rate of two and a half miles an hour, and their maps were usually drawn to a scale of three inches to a mile. Today, however, a mechanized column can move at forty miles an hour—sixteen times as fast—and in a single hour may traverse ten feet on a map of the old scale. In that single hour a bombing squadron at 300 miles an hour may span seventy-five feet of that same map.

The Signal Corps is justifiably proud that it has successfully and swiftly met the challenge of these new conditions. It has anticipated at every turn the requirements of today's warfare which are as enormous in their complexity as in their size. It has quickly and efficiently devised new equipment and methods, or revised more conventional equipment and methods, to cope with the changing demands of the expanding and accelerating tactics

Our Mechanized Forces require highly trained specialists to operate the equipment in these fast-moving reconnaissance cars.

In every theatre of operation where United States troops are now stationed, the vital communications of the Army have been made faster and more accurate by equipment that but a short time ago was a fragmentary jotting in a laboratory notebook.

The Signal Corps has met the challenge, also, by training thousands upon thousands of troops and civilians in the efficient operation and maintenance of this equipment under all conditions. It has established great schools of university proportions, has equipped them with the most modern apparatus, staffed them with expert instructors, and has produced the needed highly trained technical specialists in the fields of electricity and electronics.

The Signal Corps' alertness to the changing needs of modern warfare has reached to the very procedures and routines by which it has effected change. Almost from day to day the staff of the Chief Signal Officer has been modified, expanded and reorganized, to keep its operation ahead of actuality.

These modifications in equipment, methods, procedures, and organization have produced, in effect, a new Signal Corps. Newness and intelligent innovation, however, are traditions of the Signal Corps, for the art of communication with which it deals is itself new, and treats innovation as the rule rather than as the exception.

Today we are performing functions that were utterly unknown a few years ago, and a few years ago we were performing functions unknown a few years before that. The ascent to today's level of operation and accomplishment has been steep, for in less than one hundred years the entire art of military communications has advanced from elementary signalling with flags and torches to a gigantic activity which spreads over the globe with wire and radio telephony and telegraphy, teletypewriter installations, submarine cables, cryptography, motion and still pictures, and many other aspects of communication which cannot be divulged until the war is ended.

Looking forward, we are preparing for continuing change and are already intensively at work on new equipment and methods to maintain the effectiveness of Army communications next year, the year after, and five years, ten years after that. It is to be hoped that all these developments will not see action, but if they must, it is a satisfaction to know that the Signal Corps will have them ready. This process of ceaseless evolution and modification

(*Continued on page* 226)

Radio ops learn to handle field equipment under combat and adverse conditions. They become experts at their many tasks.

★ ★ ★

Erecting and testing a beam antenna brings back fond memories to those who were amateur radio ops in days of peace.

RADIO IN THIS WAR

Corp. Ray Spencer, motorcycle dispatch rider, cat-napping. Note the ever ready weapons. Bataan Peninsula, P. I.

Radio communications link the armed forces of the United Nations, protect our very lifeline and keep up our morale.

by Col. DAVID SARNOFF

One of America's distinguished veterans in radio communication. Born on February 27, 1891. Interest in military and naval radio goes back to World War I. As Commercial Manager of the Marconi Company from 1917-19 worked feverishly to help equip the Army and Navy of the United States with wireless. Appointed Lieutenant-Colonel, SC-Res., U. S. Army on Dec. 11, 1924, Sarnoff was promoted to the rank of Colonel on Dec. 23, 1931. Is now on active duty with the U. S. Signal Corps. Has two sons in the service. Can still handle the key with a good clean "fist" and can copy at high speed.

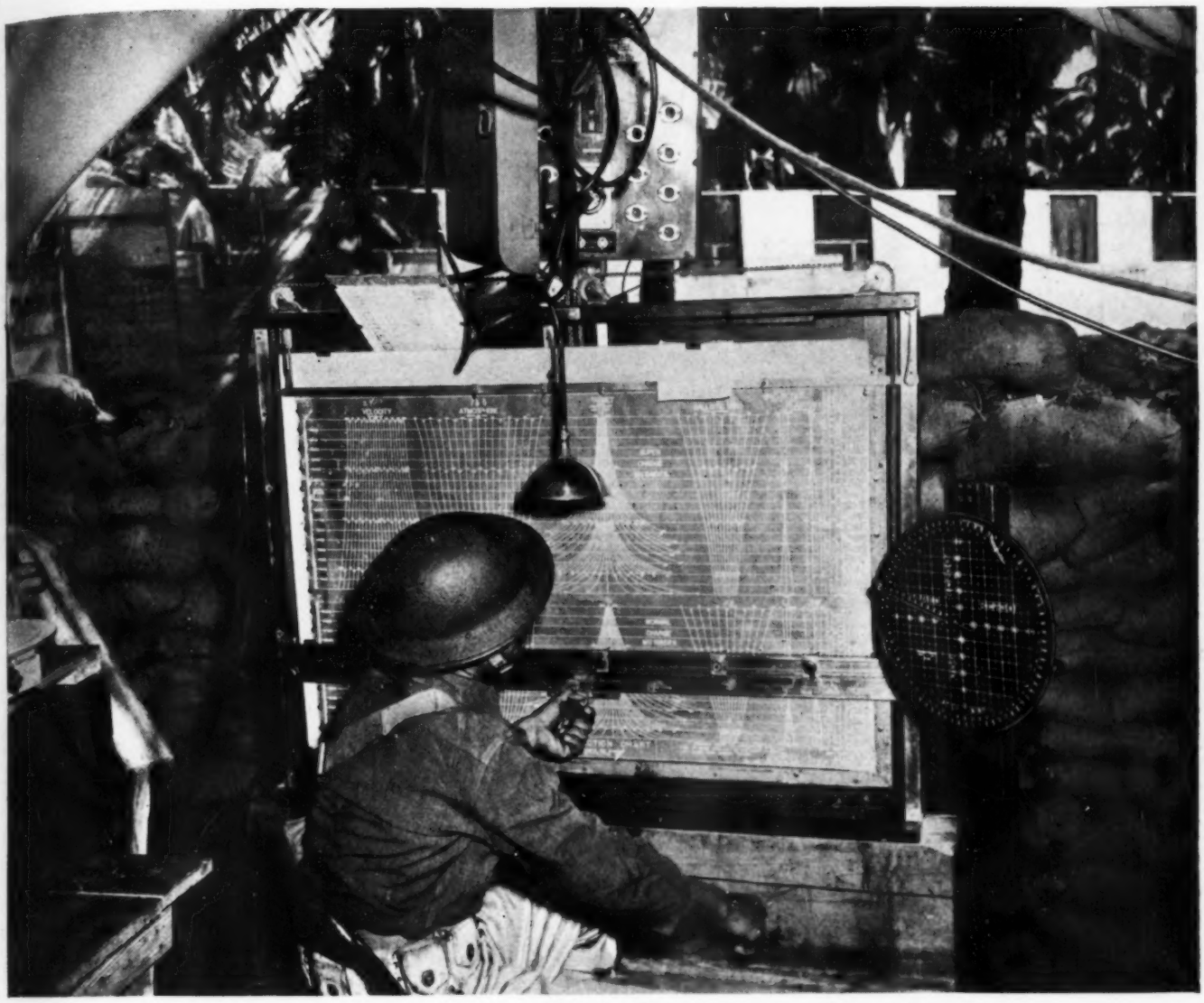
"RADIO intelligence" is a new element in the strategy and tactics of warfare. It is defined as the timely and skillful use of radio reception and transmission of military information, and the use of radio-electronic devices for other purposes such, for example, as direction finding.

Modern war hits hard and fast. Radio coordination empowers the fighting forces on land, sea and in the air to synchronize their operations and to function at high tempo without chaos. Successful handling of "radio intelligence" whether by garrisons or commandos, by submarines or the fleet, by tanks or task forces, by reconnaissance planes or bombers, is a vital factor in the formula of victory.

It is the duty of the Signal Corps to operate, maintain and guard the lifeline of communication over which "radio intelligence" is intercepted or transmitted by the army. In land combat, accelerated by mechanized units, dive bombers and swift fighter planes, orders are flashed and executed before the enemy can decode and shift his forces into action. Precision of mass air attacks by hundreds of planes is made possible by radio.

On the seas, transmission in wartime is restricted to urgent necessity. Silence guards the ships. They carry "silent" radios, but they are aurally sharp and alert. Great convoys pass in silence, lest a radio signal reveal their presence to submarines or to bombers beyond the horizon.

The enemy also is implemented with radio. Efficiency of the equipment and generalship in its use are the weights that tip the scales to victory. Radio superiority is important. The workers who build the radio apparatus are fighting alongside the soldier and sailor who use it in



A deflection board gives readings from Weather Bureau. Data is used for artillery fire.

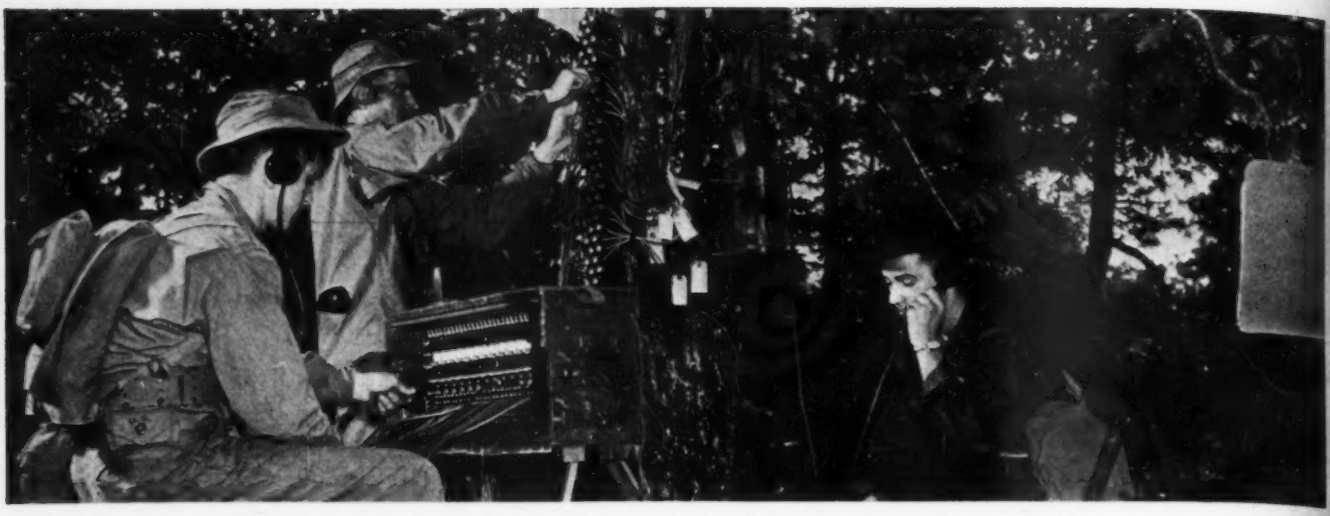
battle. The accuracy of a man in winding a coil or the delicate touch of a woman's fingers in the making of a radio tube, help to guide the bomber to the target and safely return it to the base.

Lined up behind the Signal Corps and Naval Communications as a bulwark of offense and defense is the entire radio industry, working twenty-four hours a day. Scientists and engineers in the research laboratories, the men and women on the production lines are fighting this war too. Their productive attainments are strongly supported by their War Bond purchases, the salvage of essential materials and a resolve to win.

Fully aware that wherever fighting men go, the Signal Corps must also go, the soldiers of production are engaged in an all-out effort to equip the armed services of the United Nations with the most efficient radio equipment in the world. They know that the front line in this war runs through every radio manufacturing plant and radio station, whether it is engaged in domestic broadcasting or international communication. Never has any war so completely involved the entire world. Never have the armed forces of the United States gone to fight at so many scattered points on the map. Radio unifies them as a world-wide fighting machine.

It is radio that helps to co-ordinate the infantry units and planes, and the marines and sailors on the Seven Seas. Blitz and panzer tactics cannot outwit radio communication, for radio itself travels at lightning speed. It saves time. It annihilates distance, whether at sea or on the

Computing artillery firing data is the hair-trigger job of these men. Note portable field telephone set.



Signal Corps Soldiers using field telephones and a command post telephone switchboard.

Soldiers operating a deflection board. Corrector gives range to elevation for artillery fire. Note chest-phone.

desert. Radio can talk by voice, or flash its traditional code. So effective is its use, that war correspondents report that Generals no longer direct battles from maps stretched out before them in headquarters behind the lines. They are surrounded by the smoke of the fight; they are amidst the tanks and under the bombers, giving their orders by radio. Tanks are radio equipped with rugged apparatus; air armadas have radio ears and voices adapted to the terrific pressure of war. Scouts and infantrymen carry portable "walkie-talkie" outfits. Radio helps to guard the convoy; it travels with every mechanized unit.

Radio is a formidable force, which our enemies can never dodge or encircle, for radio gets in and out of everywhere. Nothing can excel radio's ability as a scout; no mountain can block it, no curvature of the ocean can obscure or stop it. No gun or bomb can sever a wavelength. Distance is no barrier to a radio message. No sand storm can rob radio of its intelligence or stop it as a dispatch rider. Lost fleets, lost battalions belong to the past—to the Pre-Radio Age.

Generals and military strategists, Presidents and Prime Ministers talk across the sea as readily as over a local telephone; they fly the Atlantic guided by radio in less time than the fastest trains run between New York and Chicago. Yet, both radio and plane as developed today were but dreams in World War I.

Now, war is flashed and flown to the enemy—a 300-mile an hour transport plane in 1942; a 10-knot freighter in 1918; uncertain limited range wireless in the first World War, reliable, world-wide radio in this second global conflict. The enemy cannot move supply columns, or maneuver his forces with assurance that radio and plane are not watchfully following. He cannot put his radio transmitter on the air to communicate, or use his radio to guide an over-the-horizon shot, or to direct an anti-aircraft barrage, without being spotted. Radio "telegraphs" the enemy's blow. The military ear listens in on all the earth as if it were a sea shell. That is what makes "radio intelligence" so effective. A news headline after the collapse of the Midway "surprise," read: "Japanese Aim to disperse Our Forces Offset by Radio."

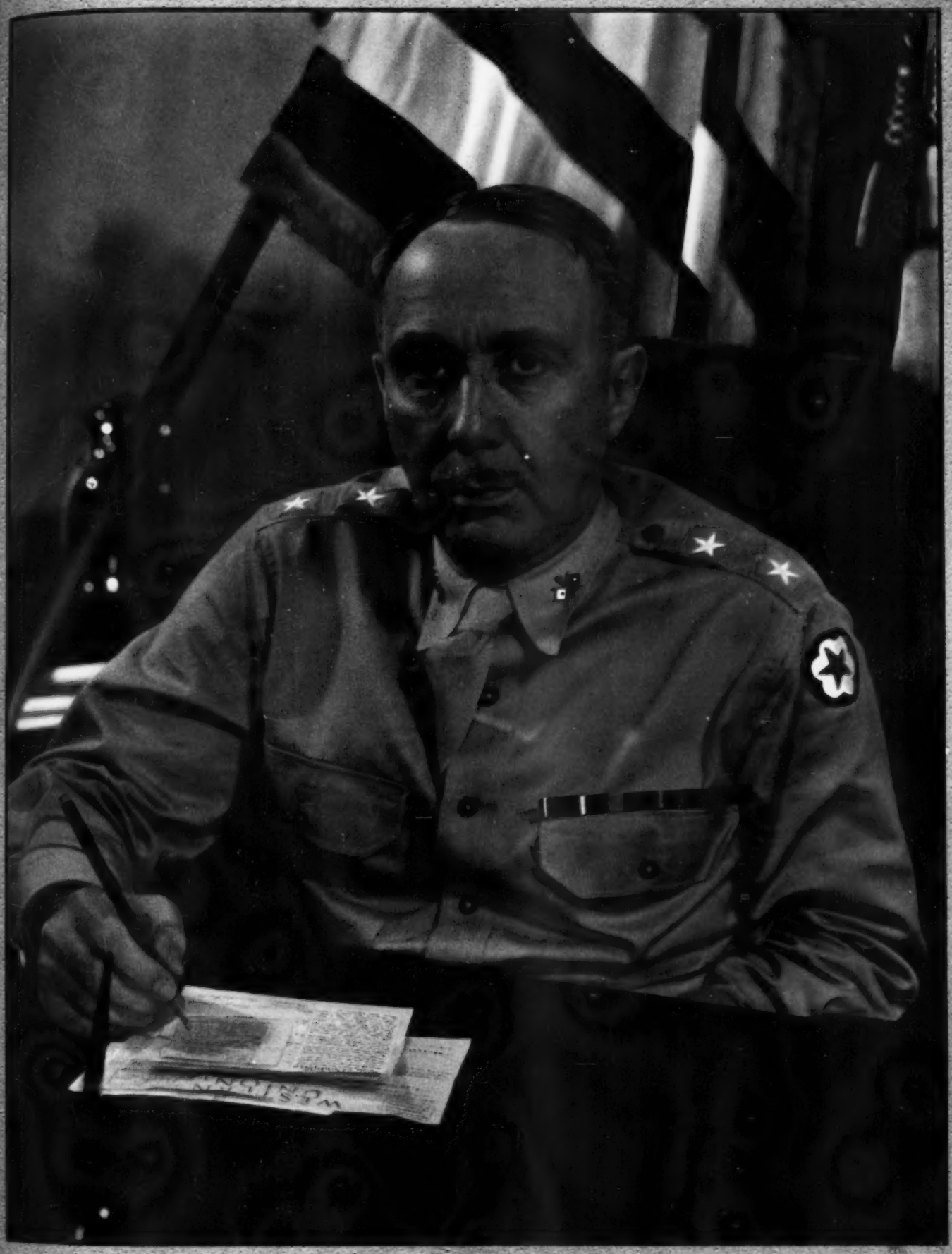
Never in history has science been so widely diverted from its peaceful pursuits and services to wage war. American ingenuity, research and engineering have made radio a powerful arm of the United States. It reaches to all the United Nations; proficiency in the application of it, is essential for victory.

Radio scientists who pursued their research tasks with no war-like motives—have been forced to adapt them for battle in order to defeat those who would harness

(*Continued on page* 160)

☆ COLOR PHOTOGRAPHY ☆

Color photos are rather unusual for radio subjects. The Signal Corps Photographers took many splendid shots especially for this issue. The most beautiful appear on the following pages



Major General DAWSON OLMSTEAD

Chief Signal Officer, U. S. Army

The Army compact portable field w
most effective. Operates on four ba

Ultra-compact field telephone set p
an important role in our communicat

Swiftly-moving command car keeps in constant touch with other mechanized units by both code and phone.

Temporary lines terminate to this portable telephone switchboard. Note collapsible legs.

Guiding telephone wire away from road. Truck ahead feeds thousands of feet in one hour.

The Army Signal Corps mobile radio unit with the companion trailer.

A complete gasoline-driven motor-generator follows this radio unit.

Rough terrain holds no obstacle for these tiny Army "jeeps." Operator is using latest uhf set.

Establishing contact with other units of these heavily-armored trucks. Note vertical antennae.

Students receiving instructions on operating a high-power portable transmitter for field use.

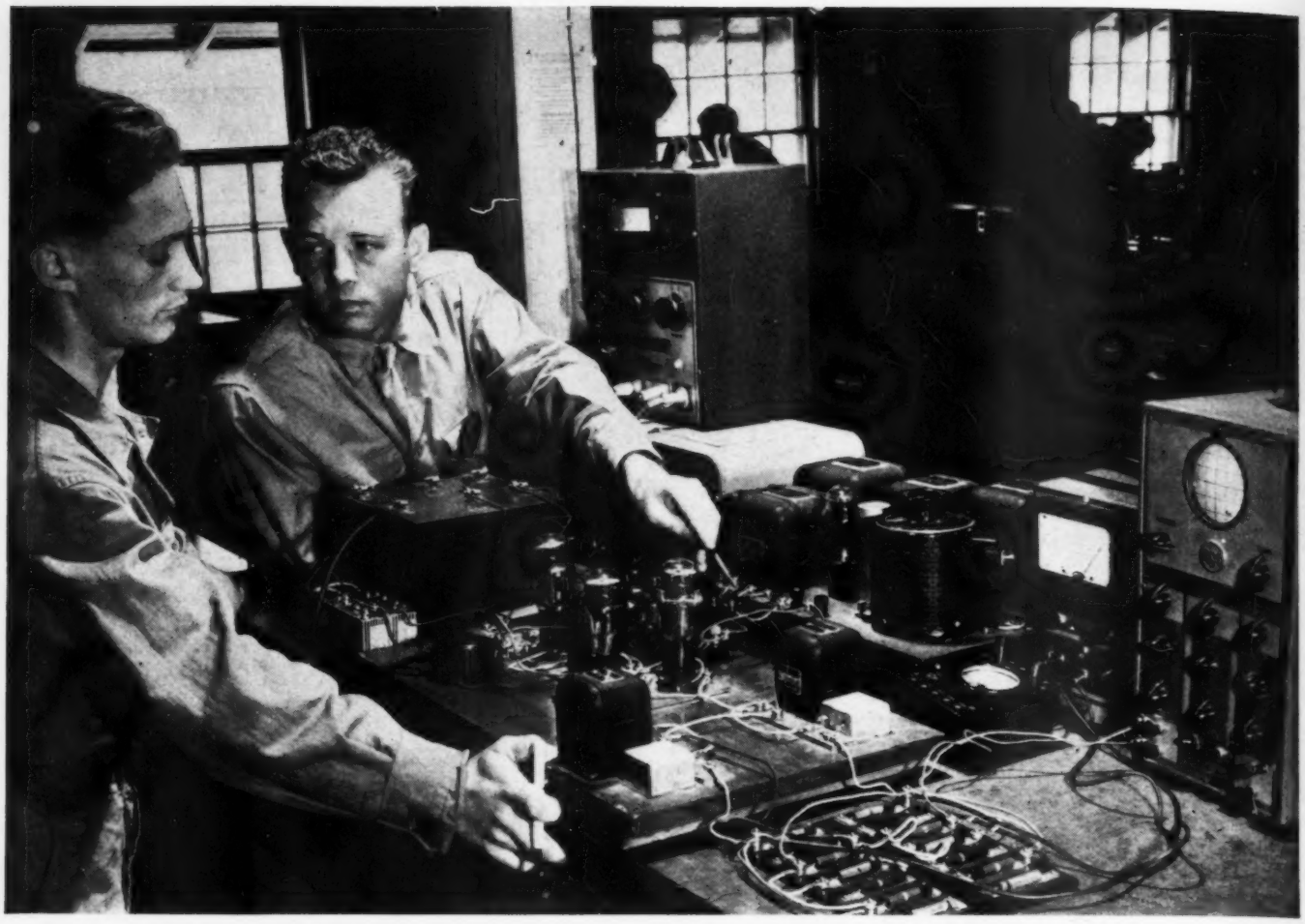
This two man team operate their radio from a concealed position. Note hand-driven generator.

Breadboard layouts of telephone circuits facilitate the teaching of fundamentals.

Reassembling a teletype machine. Student must identify and understand every part.

TRAINING

New techniques require thousands of trained operators and maintenance men to handle all Army Communications.



Breadboard layouts are used to facilitate the teaching of various radio circuits.

TRAINING

by Brig. Gen. GEORGE L. VAN DEUSEN

Born in Passaic, N. J., in 1888. Graduate of West Point in 1909. Joined the Signal Corps during World War I after having served in the Infantry and the Coast Artillery. Spent seven years as Assistant Commandant of the Signal Corps School at Fort Monmouth, N. J., of which he became Commandant in 1938. Assigned to command the Signal Corps Replacement Training Center at Forth Monmouth in 1941, later became Commandant of the Signal Corps School. A graduate of the Command and General Staff School, the Army War College, and the Naval War College. Promoted to Brig. Gen. in April, 1941.

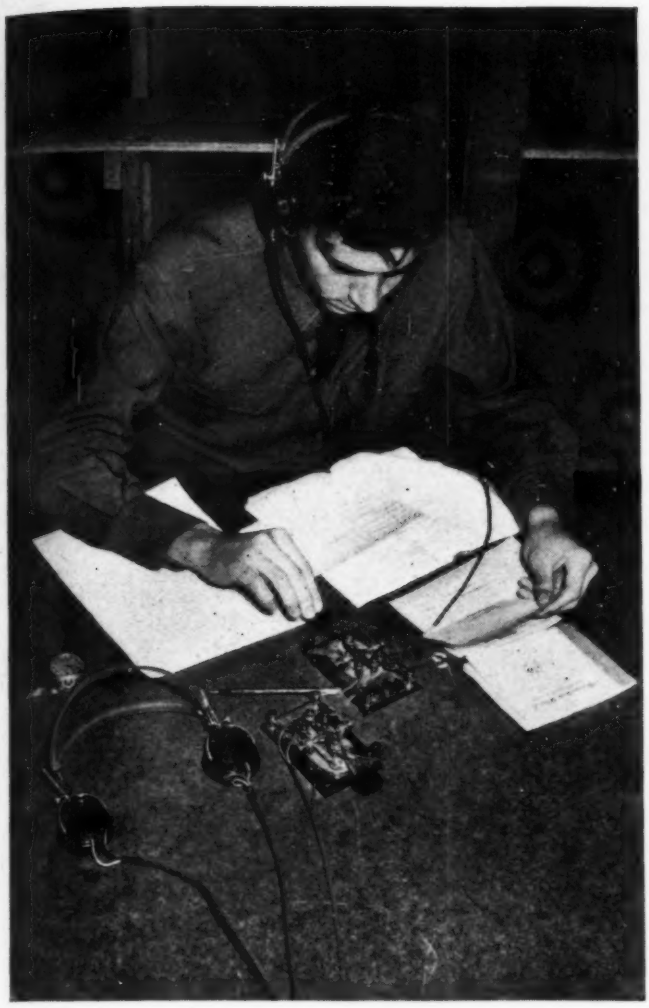
THE rapidly expanding Signal Corps is justly proud of its modern training facilities at Fort Monmouth, N. J., at Camp Crowder, Mo., Camp Murphy, Fla., and Camp Kohler, Calif. Three of these camps are new—established since Pearl Harbor to meet the vastly expanded program of the Signal Corps. Fort Monmouth is unique in its role as parent to these other three camps and as the place where Signal Corps methods of instruction were developed during the years between the wars and brought to the stage where the training program could be multiplied to vast dimensions in a matter of months.

Fort Monmouth itself has grown far beyond its original capacity with the establishment of sub-posts and the movement of many of its peacetime activities to other points. The training program described in this article is specifically that of Fort Monmouth, but it can be regarded as typical of the methods used in all the Signal Corps replacement training centers and in all of the Signal Corps schools.

Drawing for its personnel upon the vast number of Americans who in civil life were involved in some form of communication, the Signal Corps in its training program has laid emphasis on selecting those men best suited, giving them additional training in the specialties for which they show the most aptitude, and assigning them to duties for which they are best qualified as a result of the training in a Signal Corps center.

Selection of students and assignment to training at the Signal Corps Training Center at Fort Monmouth is not a "hit-and-miss" affair. Such standardized test forms as the General Electrical Information Test and the Radio Telegraph Operator Aptitude Test are used to select personnel having the greatest aptitude to receive particular training before instruction is given. This insures that the personnel selected will offer the best return for the expenditure of instructional effort, while the less apt soldiers may be assigned at an early stage to a more suitable duty.

Fort Monmouth's training program has been developed around two organizations: the Eastern Signal Corps School and the Signal Corps Replacement Training Center. The courses of instruction in all branches of the Fort Mon-



Expert instruction is given to operators in the art of code transmission and reception at all Training Posts.

Practice networks are set up to familiarize operators with correct procedures. Note shock-mounted receiver.

Code from the many tape machines are fed to this control panel where signals are fed to various classrooms.

Studying elements of radio and d.c. circuits. Student is observing current change as loop of wire is varied.

mouth training center are flexible, and are constantly being altered to adapt them to the rapidly changing concepts of modern warfare. New equipment is being developed and new methods are being adopted for operation of facilities already in use, and it is a purpose of both the Eastern Signal Corps School and the Signal Corps Replacement Training Center to adapt their courses of instruction to handle the changes expeditiously.

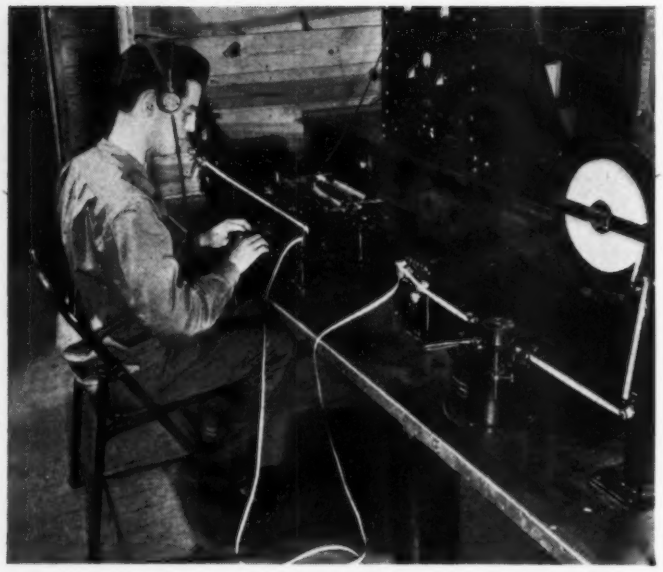
Following a basic three-week training period at a newly-formed training camp close to Fort Monmouth, all recruits are sent to the Replacement Training Center at Camp Charles Wood, a detached station of Fort Monmouth. Here intensive training begins under the guidance of competent instructors and according to the aptitudes of the enlisted man as exhibited by his scores on the tests he took after his entrance in the Signal Corps.

The Replacement Training Center turns out the following specialists: supply and administrative clerks, message center clerks, messengers, teletypwriter operators, telephone switchboard operators, linemen, auto mechanics, cooks, code clerks and field radio operators.

A significant feature of the Replacement Training Center is a carefully planned course of instruction for field radio operators. Salient features of the course include the following:

(1) Code practice periods are limited to 45 minutes or an hour at any one sitting. Two or more periods may be conducted daily, although they are separated by introducing other types of instruction.

(2) After a student has attained a receiving speed of five words a minute, instruction in sending is conducted simultaneously with the receiving instruction. At this point the training is closely supervised to insure that the



Operator reading automatic tape of high-speed radio transmission. Coordination is essential to efficiency.

Outdoor class is receiving instruction on the use of telephone switchboard used for field contacts.

student does not develop harmful habits in transmission.

(3) Instruction in radio procedure to the extent of familiarizing students with procedure signals is started as soon as the student can receive and distinguish characters. As code speed progresses, message forms, traffic, log and number sheets are introduced, gradually combining instruction in code and radio procedure.

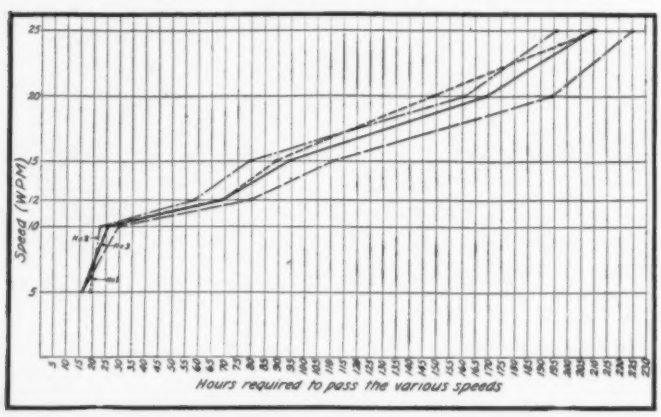
(4) Concurrent with code instruction are classroom and field sessions concerning the various types of Signal Corps radio sets. This instruction includes nomenclature, composition, methods of installing, methods of transporting, methods of destruction in the event of possible capture, characteristics, and technical design, together with such fundamental electrical studies as are necessary.

(5) Because each operator in a Signal Corps unit must be capable of operating any set in his outfit, the instruction he receives at the Replacement Training Center thoroughly covers all types of sets issued to a particular type of unit.

(6) Enough sets are provided so that a key and log operator work together. They interchange duties frequently in order to familiarize themselves with each other's work.

The minimum skill required of a radio operator is that he be able to transmit and receive in International Morse code at the rate of 15 five-letter code groups each minute for three minutes; transcribe received signals in printed characters with a maximum of six erroneous letters; set up field radio sets and make necessary connections for their operation; adjust and care for field radio sets; test and care for storage batteries.

This chart shows progress of code students. It was compiled from hundreds of average scores.



The average number of hours required to pass various speeds of the fixed station operators' course is shown in an accompanying chart.

A regular cycle of students goes through the Replacement Training Center every 13 weeks. At the completion of their training the men are ready for assignment to Signal Corps units throughout the United States and for overseas task forces. A number of selected students are retained at Fort Monmouth and receive further specialized training in the Enlisted Men's Department of the Eastern Signal Corps School. The training there includes fixed radio station operation, radio repair, cable splicing, installing and repairing telephone and telegraph systems, switchboard installation, teletypewriter maintenance, teletypewriter operation and cryptanalysis. The Eastern Signal Corps school, in addition to its Enlisted Men's Department, includes the Aircraft Warning Department, the Officers' Department, the Officer Candidate Department and the Department of Training Literature.

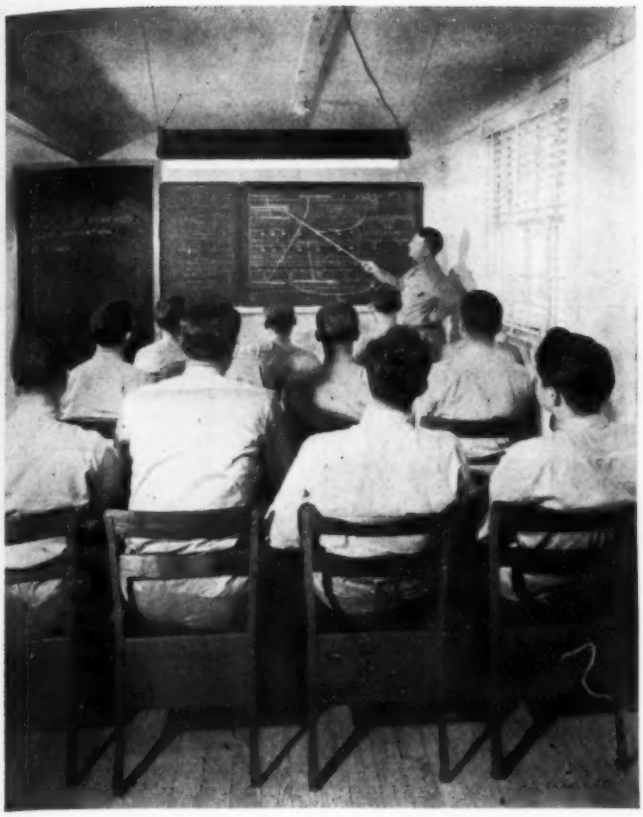
Two general types of instruction, wire communication and radio communication, are offered in the Enlisted Men's Department. Students are received from the Signal Corps replacement training centers and from tactical units. The selection of men from the training centers is based on the results of individual ratings in the Army General Classification Test and the General Electrical Information Test, as well as personal interview concerning civilian experience and proficiency in prescribed specialties.

Enlisted men, detailed for training from tactical units, are carried on detached service by their home organizations to which they return upon the completion of training. At the conclusion of their training at Fort Monmouth, certificates of completion of the course are presented the students. They are considered invaluable to the men who want to get ahead in the service and constitute an incentive for each student to put forth his best efforts.

The Aircraft Warning Department, which initiated instruction at Fort Monmouth in May of 1941, has grown so rapidly that it was necessary to open a new center at Camp Murphy, Florida. By the end of August, all instruction in the operation and maintenance of this highly specialized equipment will be given at Camp Murphy.

Largest department of the Eastern Signal Corps School is the Officer Candidate Department. Capacity of the school has increased manyfold since its beginning in July, 1941, and at the present time large classes of candidates are being graduated every two weeks with commissions as second lieutenants in the Army of the United States.

Warrant officers and enlisted men for the Officer Candidate School are selected by the commanders of the field forces, commanders of service commands, department and



Instructing a group of students in training in the theory of punch card operation used by the Signal Corps.

Students at Ft. Monmouth Training Center making line route maps. Each man has wide table on which to work.

replacement training center commanders. They are chosen on the basis that they have demonstrated outstanding leadership and possess technical and educational qualifications and personal characteristics required for officers. The three months' course is intended to teach the candidates efficient administration, training and operation of tactical units. Voluntary enlistment for Officer Candidate training is provided for men of Selective Service classifications with dependents who meet certain requirements.

The course of the Officer Candidate School is intended to teach the candidates efficient administration, training and operation of tactical units. It is divided into basic, intermediate, and advanced sections with the 657 hours of work being divided as follows:

Basic Subjects

Basic Mathematics	12
Dismounted Drill	23
Inspections	5
Interior Guard Duty	5
Map Reading	34
Mess Management	16
Military Courtesy and Discipline	4
Military Sanitation	7
Army Organization	38
Radio Code Practice	12
Safeguarding Military Information	4
Signal Supply	23
Weapons	18
Identification of Aircraft and Vehicles	11
Total	212

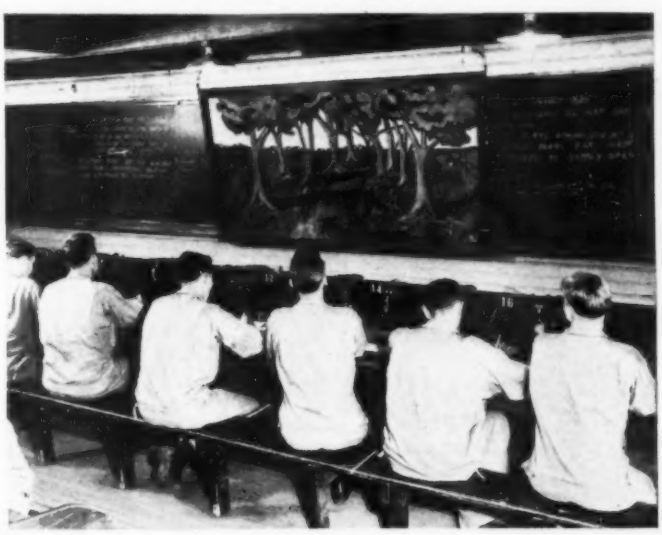
Intermediate Subjects

Administration	50
Defense Against Chemical Attack	10
Elements of Electricity	50
Inspections	5
Marksmanship and Combat Exercises Dismounted Drill	25
Motor Transportation	30
Army Organization II	20
Radio Procedure	10
Tactics and Technique of Signal Communication	30
Range Instruction	12
Total	242

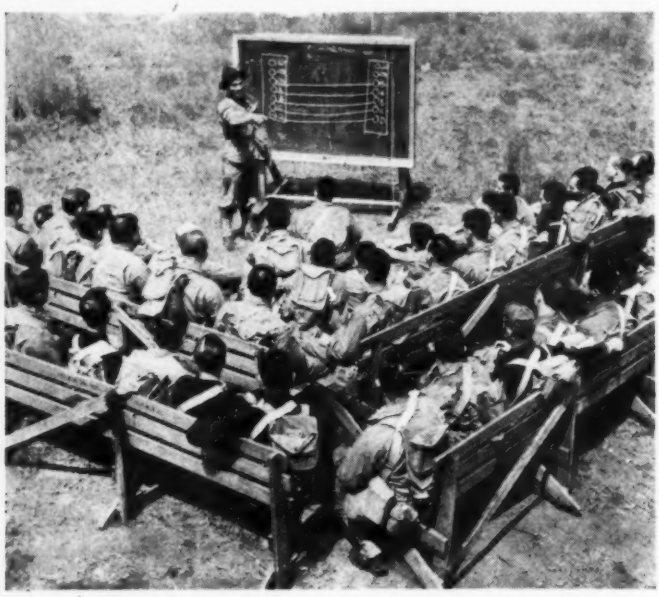
Advanced Subjects

Classification Procedure and Army Postal Service	4
Basic Signal Communication—Radio	20
Basic Signal Communication—Wire	20
Board of Officers	4
Customs of the Service	2
Inspections	5
Local Security Drill or Dismounted Drill	22
Military Law	28

Students copy code from miniature blinker light which is inserted into landscape painting in the classroom.



Signal Corps personnel must keep in physical trim at all times. Plenty of climbing is done by these radio men.



This outdoor class is studying pole line construction. The Wire Division of the Signal Corps gets plenty of action.

Streams are no hazard to these members of the Signal Corps. Ropes are here used to assist students across this barrier.

Rules of Land Warfare	4
Tactics and Technique of Signal Communication II	40
Training Management	38
Field Exercise	16
Total	203

A company officers' course of 520 hours, an advanced course of 520 hours and a division signal company officers' cadre course of 192 hours are offered in the Officers' Department for officers of the Army and the Marine Corps. The course of study is designed to qualify officers for duty in the field organizations and give them a general knowledge of the various organizations and tactics of various branches of the Army. Upon completion of a course, officers are assigned to the duties for which they have shown the most aptitude.

The 12-week company officers' course consists of subcourses common to all company officers and courses in the specialties of radio communication, divisional field wire communication, long lines outside plant, long lines inside plant, and supply and motor transport. Each student officer receives instruction in the common subcourses and in one of the various specialties.

The following list shows subcourses for company officers and the hours devoted to each:

Common Subcourses (Taken by all student officers)

Map Reading	20
General Tactics and Army Organization	76
Agencies of Signal Communication	36
Combat Orders	36
Chemical Defense	8
Training Methods	42
Company Administration	30
Military Law	12
Total	260

Specialist Subcourses (One subject taken by each student officer)

Radio Communication	260
Field Wire Communication	260
Long Lines Outside Plant	260
Long Lines Inside Plant	260
Supply and Motor Transport	260

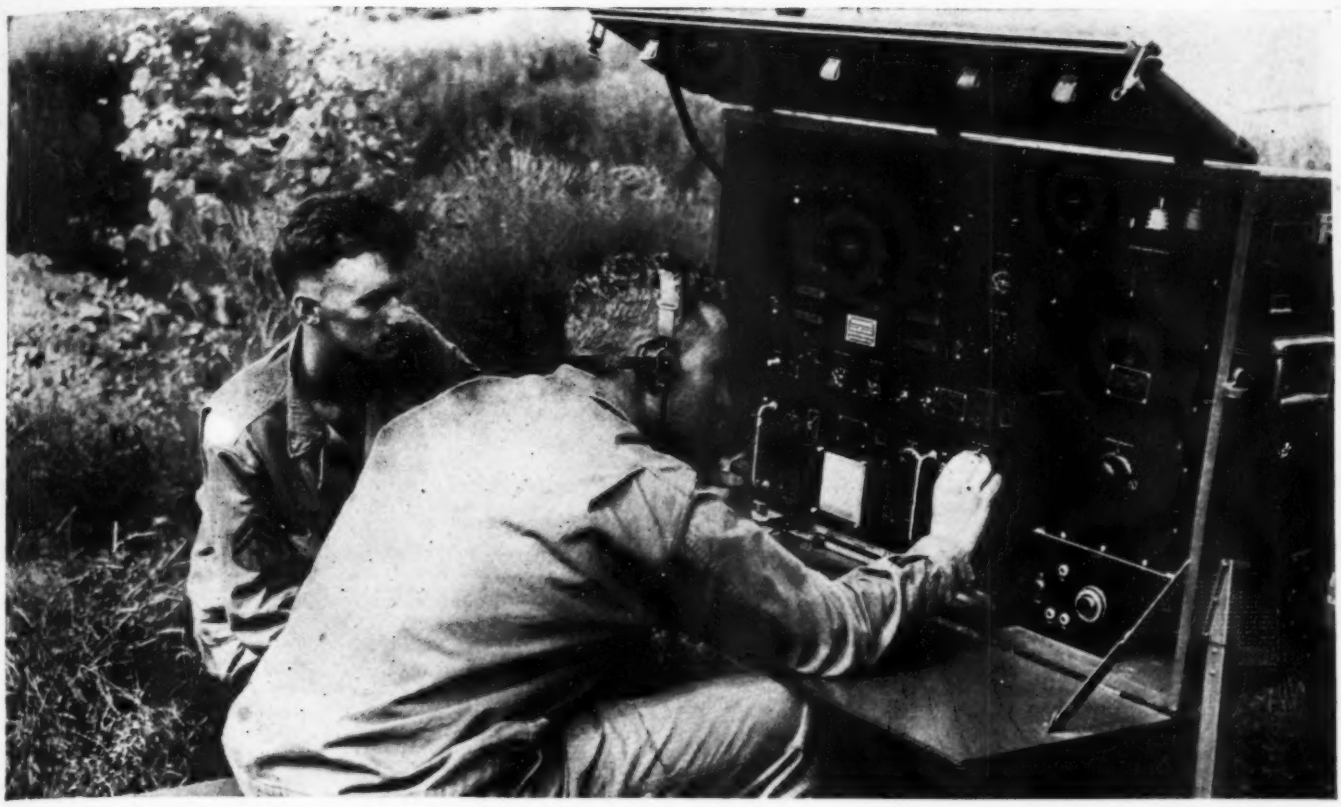
The purpose of the course for advanced officers is to instruct specially selected officers in subcourses appropriate to qualify them to command tactical Signal Corps units of battalions or larger, and to serve as signal officers for tactical units. Subcourses common to all advanced officers and specialty courses in appropriate subjects to train signal officers for ground forces as well as signal officers for the air forces are given.

Officers assigned to division signal company cadres are given instruction in the preliminary organization of their unit to include actual preparation of initial requisitions, training programs and schedules, instructional material and plans. Each company commander is required to direct the work of his cadre and is given any assistance required, such as advice, visits of inspection to available units and additional specialist training from his officers.

Instruction is provided in the cadre training course for the following types of assignments: company commander, supply officer, wire construction officer, telephone and telegraph officer, radio officer, message center officer, motor transport officer, and radio intelligence officer.

Special training for graduate electrical engineers and electronic physicists is offered by the Officers' Department in an electronics training group for duty with the Aircraft Warning Service. Commissions as second lieutenants are offered directly to qualified electrical engineers. Students in an electrical college or majoring in electrical engineering or physics in any technical school are permitted to enlist in the electronics section of the Enlisted Reserve

(*Continued on page* 144)



MSCS Radio test and repair school students operating field transmitter and receiver units.

Midwestern

SIGNAL CORPS TRAINING

by Maj. Gen. WALTER E. PROSSER

Uncle Sam is providing our military machine with qualified radio men to "get the message through" with speed and precision on every front.

Born in Indiana in 1882. Graduated from the U. S. Military Academy in 1905, being commissioned Second Lieut. of Artillery. Served with both artillery and infantry as well as with the Signal Corps. Tours of duty with the Signal Corps included commands in Alaska, the Panama Canal Zone, and the Philippines, as well as many posts in the U. S. proper. Commanded the 350th Field Artillery during World War I. Is a graduate of the Field Artillery School, the School of the Line, the General Staff College, and the Army War College. Became Commandant of the new Signal Corps School at Camp Crowder, 1942.

WHEN the recent dedication broadcast of the new, huge, Midwestern Signal Corps School at Camp Crowder, Mo., hit the airways, it flung to Hitler and Hirohito a symbolic challenge from the Signal Corps that didn't require decoding.

For the opening of Midwestern means that this school is well on its way to becoming one of the country's greatest Signal Corps training centers for the men who maintain and staff the Army's far-flung system of communications.

Not since Indian smoke signals atop Ozark hills gave way to peaceful farmlands and orchards, has the quiet, rolling countryside of Southwest Missouri seen such change and activity as went on during the construction of Camp Crowder this past year. Area by area, the Ozark scrub was tamed, the hills leveled, and regular square-cut Army buildings established. Today, the completion of Midwestern has added training facilities for thousands of men to be added to the large number being continuously shipped from the Replacement Center at the opposite end of the cantonment.

Camp Crowder is located in the heart of the Ozark country, near Joplin, Mo., close to the geographical center of the nation. Adjoining railroad and highways make the camp easily accessible to every part of the United States.

Behind the camp proper are hundreds and hundreds of acres of rugged terrain, where operators in reconnaissance radio cars, construction men building wire lines, and wire operator crews toil daily, getting the best possible workout for future tough communication problems. Up in the hills or on the banks of Bull Skin Creek and Indian Creek, lonely Command Posts rehearse endlessly in the maintenance of communications with other isolated Command

Pole-line construction students of the MSCS school make preparation for splicing cable as part of their training.

These men are busily engaged in work on combination open wire and cable lead installation. Classrooms in background.

Radio code and traffic school students learning to handle the mil (typewriter) in one of the many code classrooms.

Posts and Headquarters. Foot runners, motorcyclists, and motor car messengers supplement the speedier radio wave, the telephone, telegraphy, and field teletype. And it is Midwestern's duty to train more and more of the men who install, operate, and maintain this field equipment and other Signal Corps communication instruments.

For students, Midwestern takes the men with special aptitude from Camp Crowder's Replacement Center, and also opens its doors to the best communications troops from various branches of the Army (infantry, artillery, armored forces, etc.) all over the country.

Midwestern, whose educational set-up is similar to the parent Signal Corps school at Ft. Monmouth, N. J., then administers to the soldier a combination of tutoring, study of instruction sheets, and plenty of laboratory experience, training him to become an expert radio, telegraph, or telephone repair or maintenance man, a cable splicer or radio operator, after which he receives his field experience with a combat unit.

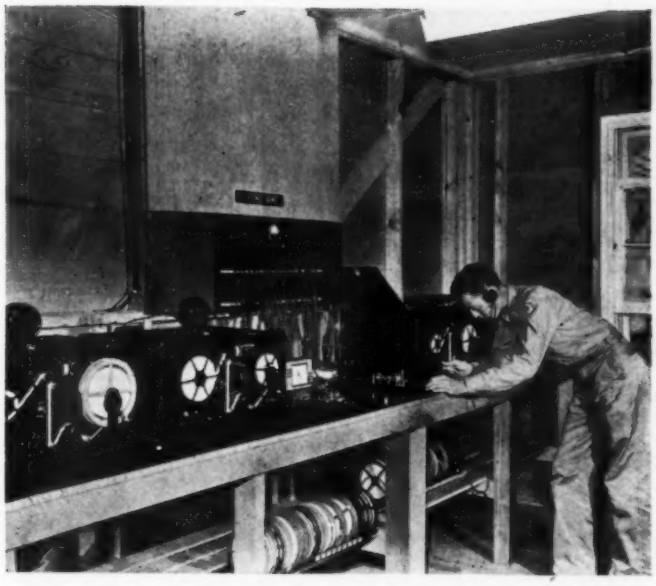
From the day a small group of Midwestern's officers and men arrived at Camp Crowder until the school's doors opened to the first students on July 1, its history was one of rapid growth and rush schedules. Twice the school's quota was upped, and existing plans had to be revised.

But the original schedule was kept, and today Midwestern is doing its share in the Army's vast training program.

The school is arranged into three main departments of study—the radio division, the wire division and the com-

Complete telephone switchboard and signal center. Temporary terminal board is connected enroute.

Inspecting an "electric eye" code keyer which is used to play back to students a record of their sending.



MSCS radio code and traffic control room. Soldier is adjusting one of the many automatic code keying units.

mon subjects division. Before beginning the study of wire or radio, each student (except radio operators) spends enough time in the common subjects division to learn principles of electricity and enough manual training to enable him to use the tools he will have with him in combat.

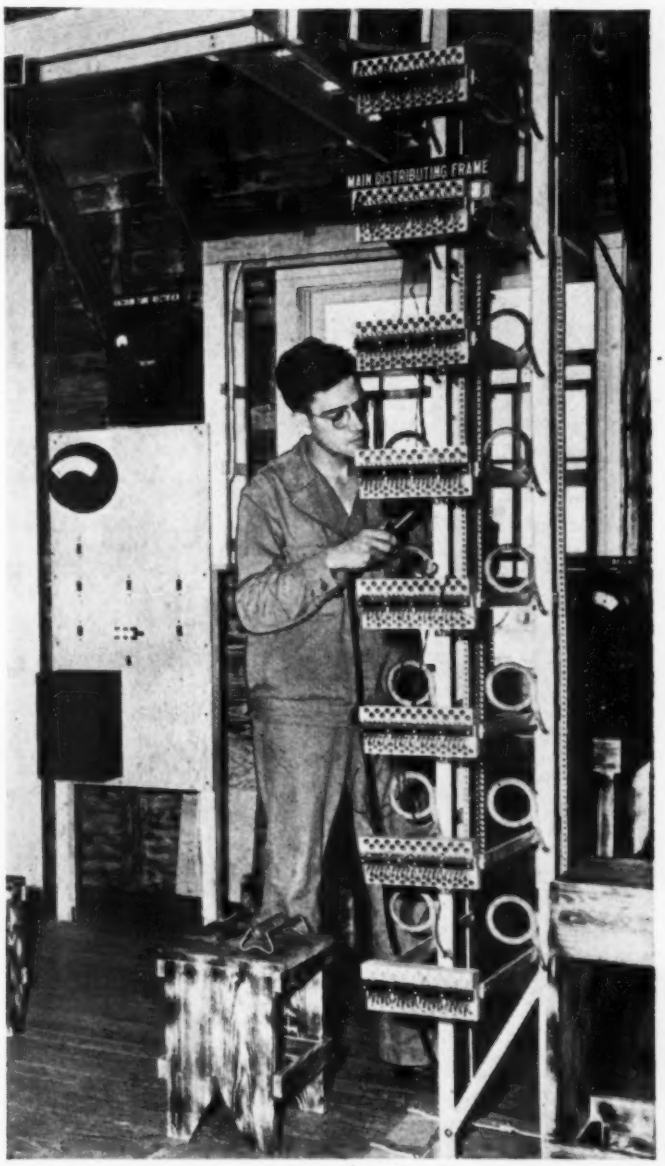
In this initial training, a careful study is made of each man's aptitude and qualifications by interview, observation and test, in order to determine exactly what his mind and hands fit him for. A man whose previous experience better fits him for service in the Engineer, Quartermaster, or any other Army branch, is usually transferred. For in today's technical warfare, the Army must insure that maximum use be made of every soldier's civilian experience.

Midwestern makes use of the "individual progress" system, in which the soldier is allowed to progress according to his individual ability and previous training. This allows previously-trained men to finish their study course quickly, and be assigned to units in which they are suitably qualified, without delay.

In Midwestern's method, there are no set opening dates for classes. Soldiers come in from the Replacement Center or tactical unit any day of the week and any hour of the day to begin their individual training. Given a schedule, each man is held responsible for getting to the proper classes on time. This individual responsibility of students is intended to develop a high degree of initiative

This group of different types of portable and field switchboards undergoes inspection by students.

A Central Office switchboard installation. Student is working with soldering iron on one of the many circuits.



This photo, taken at the Midwestern School at Camp Crowder, shows students learning teletypewriter machine maintenance.

and self-discipline, since Signal Corps soldiers often work alone in combat on highly responsible duties.

The men chosen to be trained as radio operators, both for field and fixed stations, go directly into the code and traffic department of the radio school. And the code classroom affords a good example of the modern educational methods which all Midwestern divisions pursue in training their student-soldiers.

Instruction in the code and traffic department begins with an aptitude test, and from there the initial instruction is coordination of typewriter keyboard and radio telegraph characters. There is no special formula for teaching radio operators; each man must be taught separately. One has trouble with his "H's," another with the letter "S." The proper method of training must be found for each man.

Rigid patterns of hour-long practice periods on definite code groups are eliminated. There are no rules compelling each student to spend a specified number of hours on any one part of the course. Complicating the task of the instructors is the fact that some men know touch typing, while others don't. Some already know the International Morse Code, but can't type—and vice versa. For the student operators who don't know the code, a method of oral instruction in unison is being considered. This is the method used by several civilian schools. In this method, the students in the class repeat together the code letter heard in their earphones. A student making an error is conscious of it and thus does not continue to practice a fault.

Emphasis is placed on sending. It has been found that while many men are adept at receiving, comparatively few are good senders. The students are required to copy recordings of their own sending. This is done by use of the "electric eye" automatic code keyer, which plays back to the student an actual record of his own sending. This method is also self-correction because the student copies his own sending errors and cannot pass the test until he both sends and receives correctly.

For visual reception—known as "blinkers"—, a small one-watt neon lamp is placed at each desk. This light responds readily to an impulse, because of its fast extinction characteristic. These individual lights enable each student to practice visual code reception whenever desirable. At the discretion of the instructors, student operators are permitted to spend as much time as necessary to master the code. After picking up speed, the most apt students are selected for high-speed operator training.

When a man assigned to fixed station operation can send words with the vibroplex, or speed key, at 20 per minute and can receive 25 words per minute, he is introduced to fixed station equipment. For practice, the fixed station men copy signals from actual radio stations with commercial receivers, and practice sending to each other on simulated circuits. Again the theory is that if a student can receive manually sent code copy, he will be able to handle perfect copy later.

Supplementary instruction includes the operation of high speed automatic equipment, the operation of Wheatstone perforators, and the use of the telegraph printer, as well as visual transcription of code characters from inked tapes. At the end of 90 days, the goal of the student is 25 average messages per hour, both sending and receiving. The text of all messages must be letter perfect. The message must go through correctly, regardless of the words per minute.

Those slated for the radio repairman course are given courses in electrical and radio theory before they practice on the sets they learn to repair. They are taught only those principles of radio which are applicable to Army

Working on a motor contact spring at the maintenance classroom. These complicated machines are soon mastered.

field service, because Midwestern is creating technicians, not engineers.

They learn first of all the purpose of the course and what they are expected to know:

(1) the basic fundamentals involved in the science of radio transmission and reception;
(2) how radio frequencies are produced and transmitted;
(3) how they are intercepted, detected and amplified;
(4) how they are modulated;
(5) how actual radio sets are most rapidly maintained and repaired.

The student works in the laboratory with the "breadboard" or laboratory layout of transmitters and receivers, made from real parts and not merely laboratory toys. He finds out what makes things tick by connecting instruments to the equipment and observing the results on various meters and modern test equipment such as oscilloscopes.

Later in the course he is introduced to actual transmitters or receivers when he has a practical working knowledge of its operation. As when studying the Principles of Electricity, the time spent here by the student is determined by how much radio he knew before he entered the Army, and by his rate of progress.

Final step for the radio repairman is the Radio Test and Repair School, where he actually repairs real faults on real army sets. Here for the first time he handles modern Signal Corps equipment, starting with various types of test sets, analyzers, oscilloscopes and other trouble-shooting and testing equipment, so that he can perform actual tests on all types of receiving and transmitting equipment encountered in actual field operations. When he can be relied upon to keep communications appa-

(*Continued on page* 146)

Cable-splicing student, testing a large cable with the aid of bridge—familiar to all Signal Corps men.

Radio test and alignment procedure of a Signal Corps set is being taught at the MSCS Test and Repair School.

A Scout Car radio transmitter undergoing a series of instructive tests. This one has plenty of power output.

Teletypewriter Maintenance laboratory. Students learn detail assembly and service of mechanical and electrical parts.

How ENLISTED MEN Learn

The Signal Corps instructs a large number of radio and wire specialists to handle communications in the many services.

by Maj. F. C. SHIDEL

Born in Amherst, Wisconsin. Graduated from the University of Minnesota Electrical Engineering College in 1932, and commissioned a Second Lieutenant in the Officers' Reserve Corps. Marine radio operator and broadcast station engineer. Member of Engineering Department National Broadcasting Company, when called to active duty in January, 1941. Has served several tours of active duty in the Office of the Chief Signal Officer, U. S. Army Signal Corps.

THE Enlisted Men's Department at Fort Monmouth consists of three basic divisions. The department is under the command of the Assistant Commandant and under the direction of the Director of the EMD. The three divisions are administered by Officers in Charge. The sections within the divisions are under the direct supervision of officers; the instructor detail usually consists of non-commissioned officers entirely. The department enrollment in the last year has increased more than 350 per cent. The student turnover averages between four and five months, the length of the courses varying from three to seven months, depending upon the specialty in which the student is trained. The purpose of the school is to train the various communication specialists needed by the arms and services.

The prospective student arrives at Camp Edison, Sea Girt, New Jersey, from his induction center, and there receives six weeks' basic training. Camp Edison is a subpost of Fort Monmouth. During his basic training, the soldier is tested to determine his future placement as a student by means of the Army General Classification Test, General Electrical Information Test, Signal Corps Code Aptitude Test, and in some instances, the Otis Test and the Mechanical Aptitude Test. These men, chosen as a result of these written tests, are then interviewed by various school officers. The men who are chosen for courses given at Fort Monmouth are then, at the conclusion of their basic training, transferred to either the Signal Corps Replacement Training Center or the Enlisted Men's Department.

A large number of men from field or regularly organized units, who have been recommended by their company commanders and have passed entrance requirement examinations prescribed by the Chief Signal Officer, are detailed to the Enlisted Men's Department for training in one or more specialities. Upon graduation, they are returned to their home organization and are capable of act-

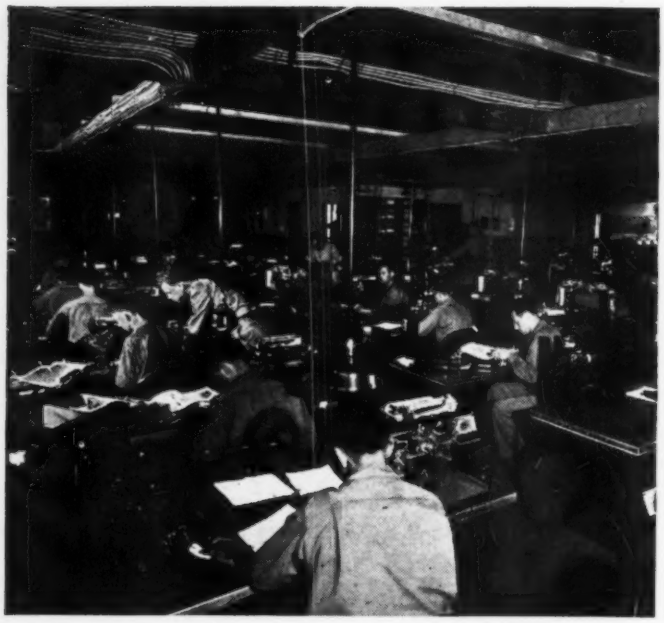
Radio transmitter test and repair by student at Signal Corps Training Center. Large tubes are 50-watters.

ing as instructors in their own unit school. From time to time selected men from the Coast Guard and Marine Corps are detailed to this school for training.

A student may, after being in the Army about three months, apply through his company commander for appointment to the Officer Candidate School at Fort Monmouth. If recommended, the student appears before a board of officers where he is thoroughly examined as to character, leadership, education, military experience, and previous civilian experience. Upon graduation from the Officer Candidate School, the student becomes a Second Lieutenant, Signal Corps, Army of the United States. Thus, a civilian can report to Fort Monmouth as a rookie, receive basic training, take training in the Enlisted Men's Department, transfer to the Officer Candidate School, and become an officer after about seven months of intensive training, without officially leaving Fort Monmouth. He could then be assigned to the Officers' Department for a short period of further training before joining a regular organization.

The applicatory method of instruction is employed in the enlisted men's courses. The students are taught correct principles and methods and their practical application. The greater part of the total instructional time is devoted to practical work covering the requirements of the particular specialty in which the student is receiving training. Until they have successfully completed a given phase of instruction, students are not permitted to progress to a more advanced phase. A partial objective in all instruction is the preparation of the student to act as an instructor, when necessary, upon being assigned to an organization. This is accomplished in part by the student's observation of the instructional material and methods used in this school. When the nature of the specialty permits, the student is also given practice in acting as instructor before leaving the school. Non-commissioned officers from regular organizations, detailed to the school for special training, take a special course in Teaching Methods.

Learning to solder on a telephone frame. Extensive practice is necessary to produce good soldered connections.

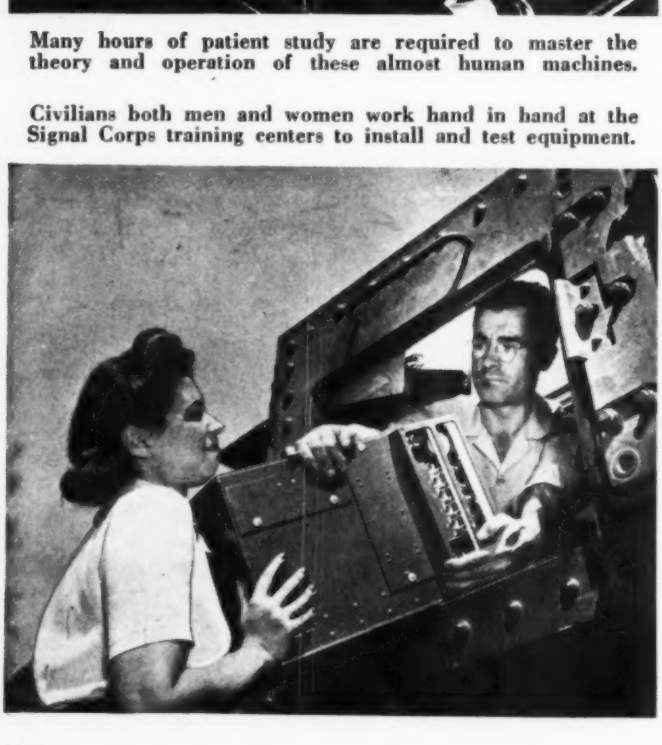


Men studying the intricate parts of teletypewriter machines. Hundreds of parts must be identified and each one studied.

Officer inspects the installation of equipment in this armored car. Note vertical antenna support on spring mount.

Many hours of patient study are required to master the theory and operation of these almost human machines.

Civilians both men and women work hand in hand at the Signal Corps training centers to install and test equipment.



At the conclusion of each subcourse pertaining to a specialty, students are required to take a final examination therein. A score of at least 70% is required for satisfactory completion of most subcourses, required completion scores in some others being higher. Any student having adequate knowledge of any of the subcourses, upon entering the school, may be exempted from the work required to complete such subcourses, by the assistant commandant, upon recommendation of the director, Enlisted Men's Department.

Instructors rate each student in each subcourse on the qualities demonstrated during the course. The qualities rated are: aptitude, military bearing and neatness, attention to duty, tact, conduct as a soldier, initiative, intelligence, and dependability. The ratings for each quality are the standard War Department Efficiency Report ratings—unsatisfactory, satisfactory, very satisfactory, excellent, and superior. These ratings are consolidated into a final rating and forwarded to the student's company commander upon the student's graduation from the school; they are also made of record in the Director's Office and in the Office of the Secretary of the Signal Corps School. Certificates are awarded to students who satisfactorily complete one or more subcourses pertaining to any one specialty, and who obtain satisfactory personal ratings. Certificates as journeyman, apprentice, or helper are issued according to the character of the work completed by the student.

Courses for enlisted men of the Army of the United States conducted in this school include the Radio Communication Course, the Wire Communication Course, and such other courses as are prescribed by the Chief Signal Officer from time to time.

The object of the radio communication course is to qualify personnel in one or more of the specialties of radio operator, slow speed; radio operator, high speed; radio operator, fixed station; radio repairman, field equipment; radio repairman, Air Corps communication equipment; radio repairman, UHF equipment; and teletypewriter operator. The subcourses applicable, in whole or in part, to the above specialties include Principles of Electricity; Shop Work; Code Practice; International Morse alphabet; Field Station traffic; Field Station traffic, advanced; Fixed Station traffic and Signal Lamps; Installation and Operation of Field Radio Nets; Elements of Radio; Test and Repair of Field Radio Equipment; Operation of Fixed Radio Station Equipment; Radio Procedure, Field Nets and Fixed Nets; Touch Typing, Teletypewriter Procedure, Teletypewriter Traffic Practice, Teaching Methods (for

Periodic inspection and tests of all radio equipment are made to insure best possible performance in combat.

NCO students only); Air Corps Communication Equipment and UHF Equipment.

In the Principles of Elecricity subcourse, instruction is of a practical nature and covers the basic principles of electricity and magnetism which will enable the student to understand the circuits and functioning of field radio equipment. It includes laboratory work in a very well equipped laboratory.

Instruction in the Shop Work subcourse covers the use and care of the tools commonly employed in the repair of field radio and wire communication equipment. The instruction is entirely practical and is conducted in a model shop well equipped with the necessary tools and facilities.

The Code Practice subcourse is divided into five sections. In the International Morse Alphabet section, instruction is entirely practical and covers training in the reception and transmission of International Morse characters until the student is able to send and receive at the rate of 10 words per minute. Instruction in the Field Station Traffic section is also practical and is intended to familiarize the student with field message forms while increasing his speed to 15 words per minute. The Field Station Traffic, Advanced section gives practical instruction intended to familiarize the student with message forms as used in field nets while increasing his speed to 25 words per minute. The telegraph typewriter is employed in this subcourse. The Fixed Station Traffic section offers practical instruction intended to familiarize the student with message forms as used in fixed nets while increasing his speed to 35 words per minute. The Signal Lamps section offers a practical course in sending and receiving International Morse code by means of light beams. All radio operators are trained in this subcourse until they have reached a speed of ten words per minute. The instruction includes training in proper procedure, installations, and adjustment of signal lamps.

The Installation and Operation of Field Radio Nets subcourse offers training in the installation, adjustment, and operation of field radio sets in field nets.

Instruction in the Elements of Radio subcourse covers the elementary principles of radio theory and of basic radio circuits. Instruction is made practical by requiring the student to construct and analyze progressively the simple and more complicated types of radio circuits. The laboratory equipment available for student use is of excellent grade.

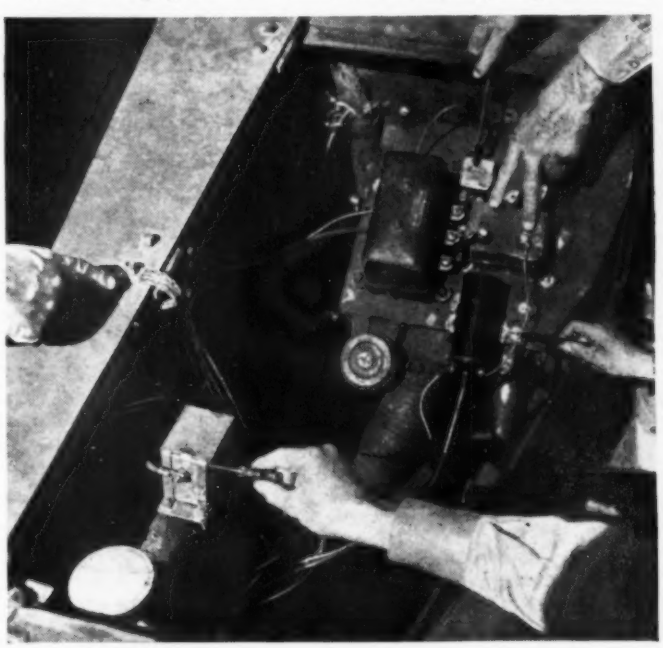
The Test and Repair of Field Radio Equipment sub-

(*Continued on page* 136)

These men learn to erect poles and to string and test all circuits in quick time. Rain or snow is no handicap to them.

★ ★ ★

Six points show new system for the suppression of noise in vehicular equipment. All units will eventually be protected.



"PHOTO BY U. S. ARMY SIGNAL CORPS"

by Col. RICHARD T. SCHLOSBERG

The photographers of the Signal Corps are always on the job—recording the history of the Army—wherever it may be engaged—at any time.

Shooting pictures while under enemy fire is all part of a day's work to these photogs.

Born in Maine in 1895. Graduate of Bowdoin College, the Infantry School, the Signal School, and the Command and General Staff School. Commissioned a Second Lieut. in the Infantry Reserve, 1917, went to France in 1918. Commissioned a First Lieut. of the regular Army in 1920, promoted to Captain, 1930; Major, 1938; Lieut. Colonel, 1941; Colonel, 1942. Transferred to the Signal Corps in 1926. Became Officer in Charge of the Photographic Division of the Office of the Chief Signal Officer in 1937. Chief of the Motion Picture Prod. Division, Army Pictorial Service.

FAMILIAR to newspaper and magazine readers everywhere is the credit line "Photo by U. S. Army Signal Corps." Under photographs of smartly uniformed troops on parade in times of peace, or of tanks rolling into action in actual battle, this slogan identifies the work of Signal Corps photographers who are constantly at work recording in pictures the history of the nation's Army wherever it may be engaged. As an identifying legend, however, it has a far wider meaning; we may take it as representing the whole broad sweep of the photographic activities of the Signal Corps.

The range of those activities is a decidedly comprehensive one, including a good many undertakings which are comparatively little known. The Signal Corps profits greatly by the thoroughgoing cooperation of the photographic and motion picture industries of the country.

In this article, then, we shall let the familiar credit line apply to a verbal motion picture of manifold action in the utilization of every photographic means to get war on the record, to carry the message of the Army to the people, to help in training soldiers to do their duty well, and to serve numerous other purposes. In keeping with its tradition of alertness in bringing every new technical development into early use, the Signal Corps began work with photography in 1881, when practical cameras were still comparatively young, and in the years since then has expanded its work in step with the growth of the art. Its facilities today include virtually every special technique of still and motion pictures, including sound recording, animation, and other special processes.

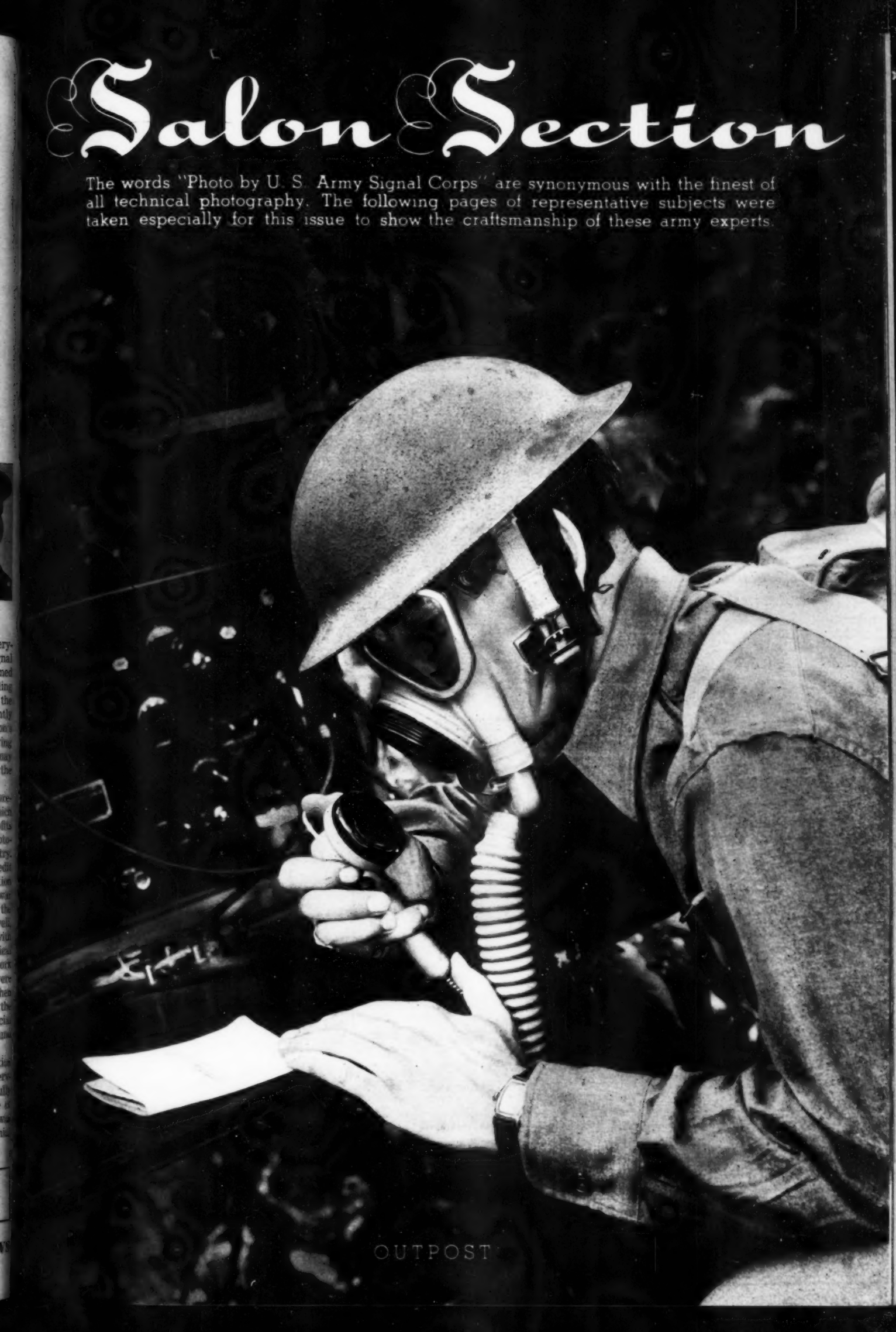
Systematic organization is essential for proper operation, so the Army Pictorial Service—as the photographic service of the Signal Corps is known—has been carefully planned on a functional basis. The APS itself is one of the four Services into which the Corps as a whole was grouped by Major General Dawson Olmstead, Chief

(*Continued on page* 91)

Technical Data on the photographs appearing in the Salon Section is given on page 281.

Salon Section

The words "Photo by U. S. Army Signal Corps" are synonymous with the finest of all technical photography. The following pages of representative subjects were taken especially for this issue to show the craftsmanship of these army experts.



MILES OF IT

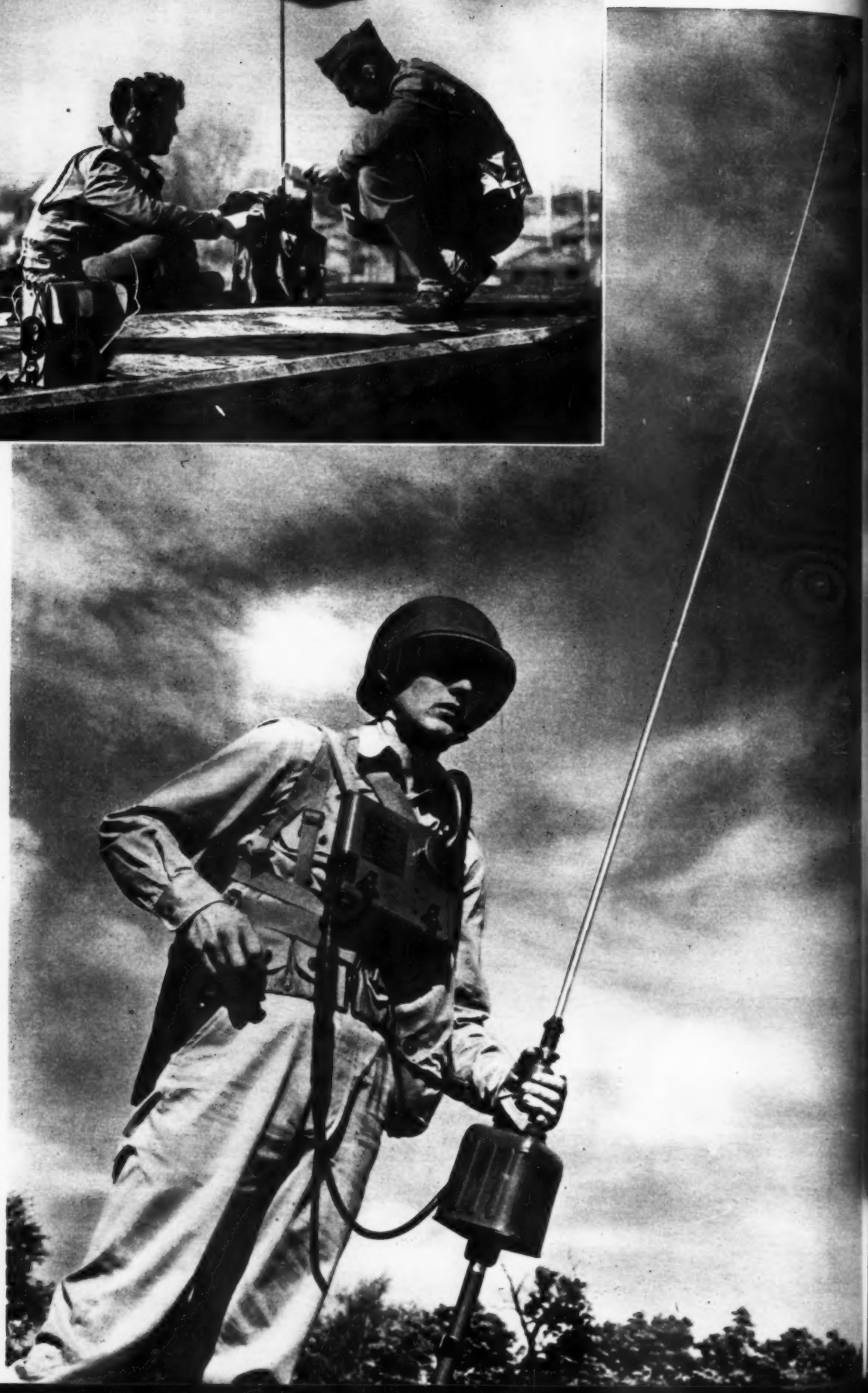
UNDER FIRE

SKY BOUND

METEOROLOGIST

HOT LEAD

SIGHT AND SOUND



ON THE HOOF

TANK TALK

TERMINUS

POLE CLIMBERS

TROUBLE SHOOTER

MISS AND MONSTER

TANK BUSTERS

SKIRMISH

PANCAKE

FORECAST

TAPE SENDERS

STUDENTS

OHM'S LAW

HEADQUARTERS CALLING

ORDERS

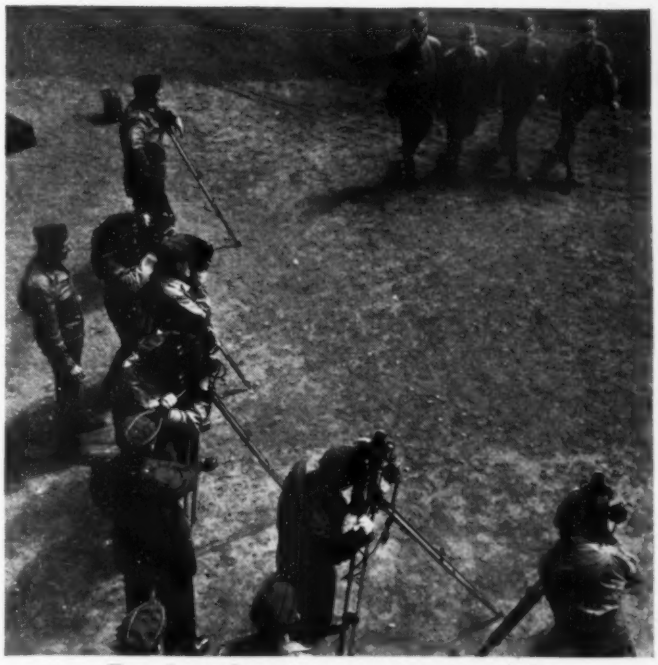
"PHOTO BY U. S. ARMY SIGNAL CORPS" *(CONTINUED)*

Signal Officer, during general reorganization last spring. Colonel Kirke B. Lawton, as Director of the Army Pictorial Service, is responsible to General Olmstead. To Colonel Lawton are responsible the chiefs of the three Divisions of the APS—the Motion Picture Production Division, the Pictorial Administrative Division, and the Field Activities Division. Each of these Divisions in turn contains several Branches, the number and functions of which are determined by the work of the Division.

All military photographic services for the Army, except aerial photography and ground photography connected with it, are provided by the Signal Corps, which also is charged with providing all photographic equipment and supplies for the Army, with the same exceptions. The photographic functions of the Signal Corps include the procurement and supply of still and motion pictures for historical records, information, legal evidence, training, identification, photomail service, and photographic records. The Corps in addition acts as custodian for the permanent photographic records of the Army in collaboration with the Archivist of the United States; provides combat photographic service for the Army Ground Forces; provides services for production and distribution of military training films, film strips and orientation films for all agencies of the War Department; acts as custodian of all foreign military and naval motion pictures, maintaining liaison with foreign attaches for this purpose; and procures and supplies photographic equipment for United States military attaches, military missions, and other individuals and agencies of the War Department in localities where Signal Corps photographic service is not available.

At the Signal Corps Photographic Center in Astoria, Long Island, a school for combat photographers trained to use either still or motion picture cameras has been established. Appropriately enough, it is housed in a building that was a well-known motion picture studio in the days of the silent films. The school accommodates about 150 men, half of whom are trained in still photography, and half in motion picture work. The course given by the school does not cover basic photography, for the candidates are carefully selected, to insure that they are familiar with the fundamentals. Since the course is completed in six weeks, a photographer may be ready for useful service to the Army within ten weeks of his induction—time being thus allowed for assignment and basic military training before the man enters the photographic school. The men trained at Astoria are assigned to photographic companies, each consisting of motion picture and still units, one such company being attached to each mobile field Army to make a graphic record of tactical situations in the theaters of operation. The photographic school at Astoria, the only one of its kind, is reserved for enlisted men, a large percentage of whom after assignment to photographic companies qualify as noncommissioned officers or as technicians in the higher pay brackets.

The Photographic Center does many other things in addition to training photographers. It is organized for the production of training films, of film bulletins, of foreign language versions, and of miscellaneous motion pictures. It likewise procures and supplies production equipment and materials, and of course is so set up as to provide for proper administration and operation of its varied activities. In the training of still photographers, the Photographic Center has had the wholehearted co-operation of the major picture syndicates and the New York City newspapers. These volunteered to accept for training as many Signal Corps photographers as their facilities would accommodate, and each worked out a course of personal instruction under the tutelage of regular staff news cameramen. The students were taught to analyze picture stories, acting the capacity of observers, and thereafter were sent out on assignments by themselves or in company with staff photographers. They thus have the benefit of working with skilled old timers who shared generously



Test shots of moving troops are part of the instruction given the Signal Corps photogs.

all the tricks of the trade which they had learned in long years of photographing all kinds of events from the news point of view, and of getting finished prints ready for early deadlines. It is not expected to make the students experts in news photography in the time available for the course, but examinations before and after the course have showed clearly that each student advanced sufficiently to enable him to do effectively the jobs assigned him.

The Signal Corps Production Laboratory at Wright Field, Dayton, Ohio, is another center of Signal Corps photographic activity. Like the Photographic Center at Astoria, the Production Laboratory is equipped for the production of motion pictures and film bulletins. At Washington, D. C., is the third focus of the Signal Corps'

Closeups require a careful analysis to insure getting a good picture. These are plate cameras.

Demonstrating the action of the flash gun is an important part of training in the school.

photographic work, in the Signal Corps Photographic Laboratory, housed in a building on the grounds of the Army War College. This is primarily a processing plant, responsible for the processing of motion picture film sent in by units operating in the field. Field units process their own still pictures, duplicating being done by the central laboratory. The Washington laboratory is by way of being a true photographer's paradise, with hypo by the hogshead, every latest device for the control of quality in production, and an unremitting program of work designed to turn out the best possible result. About five million feet of motion picture film are handled here each month, about three million being 16-millimeter film, the rest 35-millimeter.

The Photographic Laboratory at Washington is the center for production of film strips—a half way point between still and motion pictures—which are being used extensively in the training of troops in all arms of the service. The film strip is a series of frames on 35-millimeter film, for projection through a regular slide projector. The frames taken as a series tell a story or explain a process, but each frame can be held on the screen as long as the operator or instructor may desire, thus affording ample time for explanatory discussion. The photographing and distribution of these film strips for all branches of the Army are done by the Signal Corps Laboratory at Washington. Charts, diagrams, photographs, cartoons, tabulations, and all sorts of other useful teaching material are combined in the strips. Each arm of the service has a film strip preparation unit which works out the basic idea of material useful in teaching in that particular arm. The elaboration of the idea, the necessary art work, and the production are done by Signal Corps workers. About twelve new strips are being produced each month, and about 20,000 prints of film strips are being made monthly at the Washington Laboratory.

Ready for action are these graduates of the photography school with their press cameras.

Signal Corps laboratories are under the direction of Signal Corps officers, and are staffed in part with enlisted personnel, in part with civilians. More and more opportunity for women civilian workers is developing in the laboratory, as is true in the photographic and motion picture industries generally.

It would be interesting to detail further the equipment and organization which outfit the Army Pictorial Service to do the many tasks set for it. In an article surveying the highlights of the whole picture, however, we can hardly do more than mention the developing machines turning out 16-millimeter prints at the rate of 125 to 150 feet per minute, the use of standard movie-studio techniques to assure evenness of light values in the final film, the appliances for continuous and step printing, the meticulous cleaning processes used to insure clean negatives and consequent scratches and blurless prints, the continuous control of developer through the use of sensitometric test strips, the acoustically treated projection rooms for the test runs of sound films, the provision of the latest and most refined apparatus for the recording of sound and the incorporation of proper sound tracks into films. In sum, it can be said that the Signal Corps has through the co-operation of industry been supplied with the best equipment possible for the performance of its work, and that its photographic armament is constantly being improved and expanded as needs and opportunities allow.

Among the variegated activities of the Army Pictorial Service, the work of the special projects branch of the motion picture production division is a matter of interest. Here have been produced films whose purpose it is to take the Army into the factory—that is, to show gatherings of industrial workers how the results of their work are put to use by the Army. The first picture of this sort met with such enthusiastic reception from workers and managers alike that a series of "War Films," consisting of one release a month, was put into production. Considerable demand for these films from commercial movie houses has been expressed, but for the time being they are being shown only to factory gatherings, for it is felt that those who build the weapons and machines on which the Army depends should have first call on seeing how their handiwork is used in fighting the battle of democracy. In the preparation of films under the special projects branch, the Signal Corps is fortunate in the cooperation of Hollywood film specialists, some of whom donned the uniform of the Corps. Hollywood likewise cooperates in the production of all types of training films. Many valuable training films have been produced and many others are in production. The complete facilities of this great industry have been made available to the Signal Corps for this important work.

Those facilities added to the extensive training film production facilities operated by the Signal Corps at Wright Field and New York make possible the accomplishment of the great motion picture production task assigned to the Signal Corps. During the past year, these combined agencies produced 275 different training films, consisting of a total of 830 reels. Nearly 70,000 prints of the subjects were distributed in the past year to American troops in training here and abroad. This distribution represents a total of 144,000 reels of training film produced and distributed by the Signal Corps for use in Army train-

(*Continued on page* 216)

METEOROLOGY

Success or failure of a mission may depend upon weather forecasting.

Two feminine Signal Corps General Development Lab. workers about to release a meteorological balloon. Note position of parachute.

Girl on left holds tiny radio set which sends various codes.

METEOROLOGY

by Lieut. Col. OSCAR C. MAIER

MARK TWAIN'S complaint that everybody talks about the weather but nobody does anything about it still holds true. Nobody can do much *about* the weather; a great deal can, however, be done *with* it by people who have dependable knowledge of what it is likely to be. Today, in these terms, something is being done with, and therefore about, the weather by the Navy, the Weather Bureau, and the Army. The weather is taken into account in the planning, design, and testing of all military equipment. The Signal Corps, which for twenty years between 1870 and 1890 was responsible for meteorological studies and weather forecasts for the entire United States and is thus the progenitor of the present United States Weather Bureau, now confines its meteorological work to military purposes, civilian weather reporting being done by the Weather Bureau.

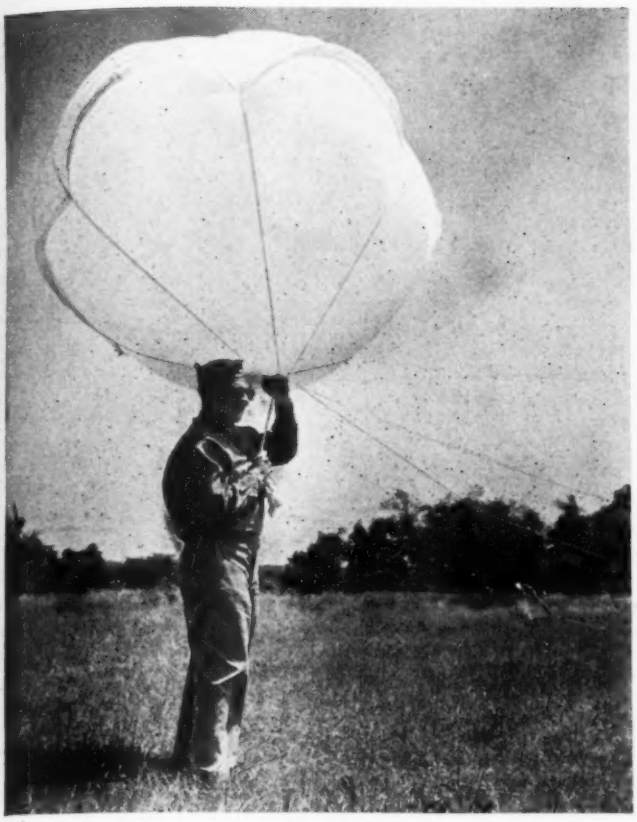
In its weather-studying function, the Signal Corps of the United States Army is charged with the responsibility for research and for the development, procurement, supply, and issue of meteorological equipment to the using Arms. This work is thoroughly in keeping with the Signal Corps' traditional mission—"to get the message through"—for meteorological service consists essentially in securing and assembling as many messages as possible about the state of things overhead, and interpreting these results in the light of both experience and the most highly developed theories of analysis.

The necessity for accurate and dependable meteorological information is probably greater in this war than ever before in military history, for reasons which require but little explanation. As more and more use is made of aviation, and as greater and greater accuracy is sought in controlling gunfire, two of the principal reasons become apparent. The military uses of meteorology are in fact as widespread as the civilian uses. Some of the correspondences are suggested by this tabulation:

Civilian Life	*Military Life*
Weather Forecasts	Operations Forecasts
Air Travel	Bombing Missions
Crop Forecasts	Chemical Warfare Service
Motorists' Guide	Armored Force, Infantry, and Field Artillery Operations
Frost Forecasts	Change in Diet and Clothing

In recent years, meteorological research all over the world has been greatly expanded because of the far wider need for information about the weather as civilian life has been speeded up, as economic activities have become more

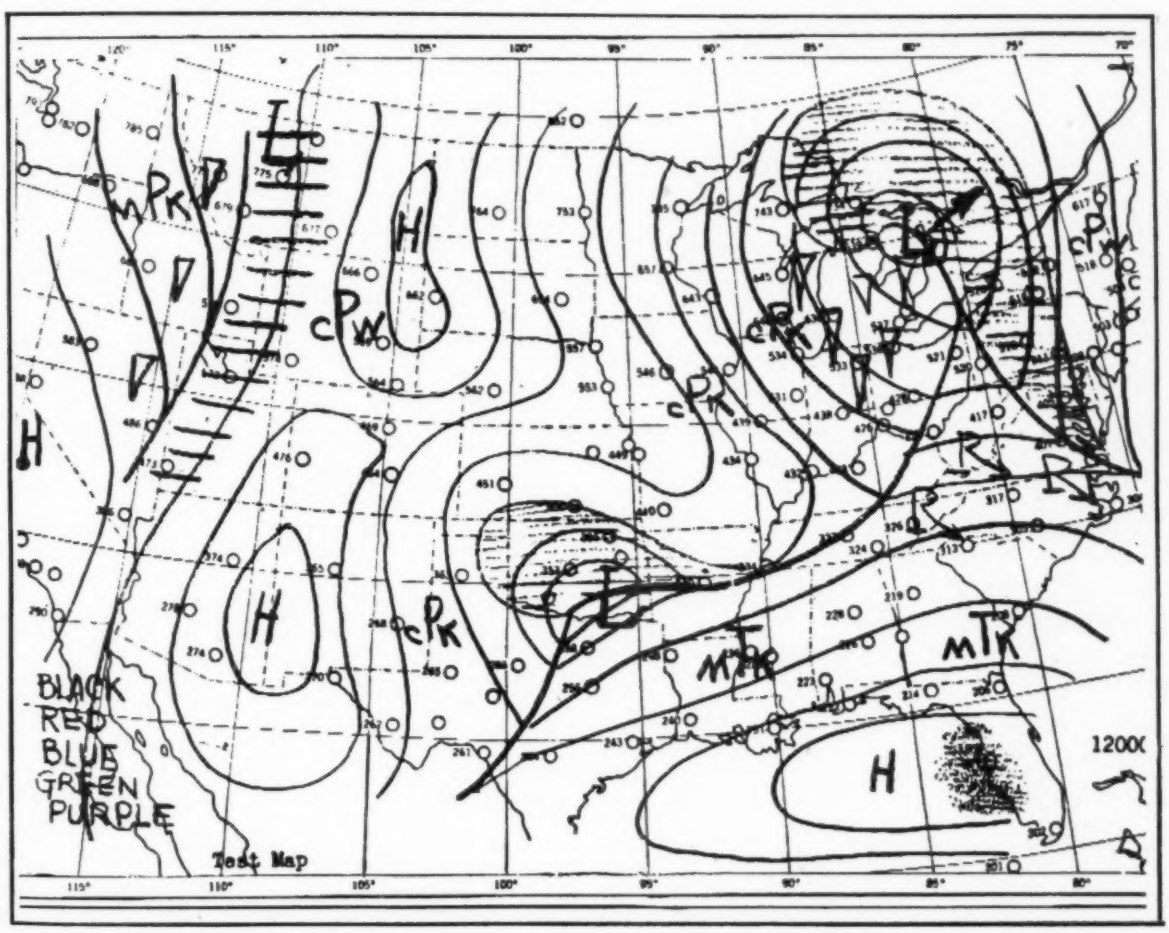
Born in Poland, September 4, 1901. Graduated as a Second Lieut., Signal Corps, June 12, 1925, from the U. S. Military Academy. Graduate of the Signal School in 1926, stationed in California for meteorology study, where he became one of the outstanding Army "weathermen" previous to the organization of the present weather bureau system. Promoted to 1st Lieut. Oct. 1, 1930; to Capt. Aug. 1, 1935. Served with the Army Air Forces in 1937-38. Became a Major, Signal Corps in 1941, and is now Director of the Signal Corps General Development Laboratory, Ft. Monmouth.

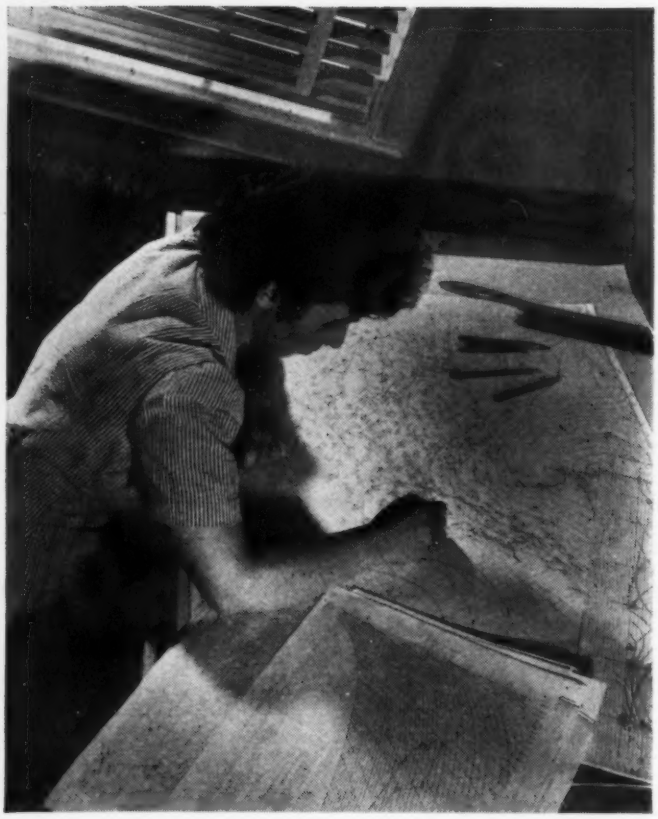


Many different types of parachutes are required by the personnel of the General Development Laboratory staff.

A feminine worker at the Signal Corps Development Lab. checking meteorological equipment. Note double loops.

Test map used by the General Development Lab's shows weather conditions in different parts of the country.





This worker is preparing a weather map which is to be used in the meteorological section of the Laboratory.

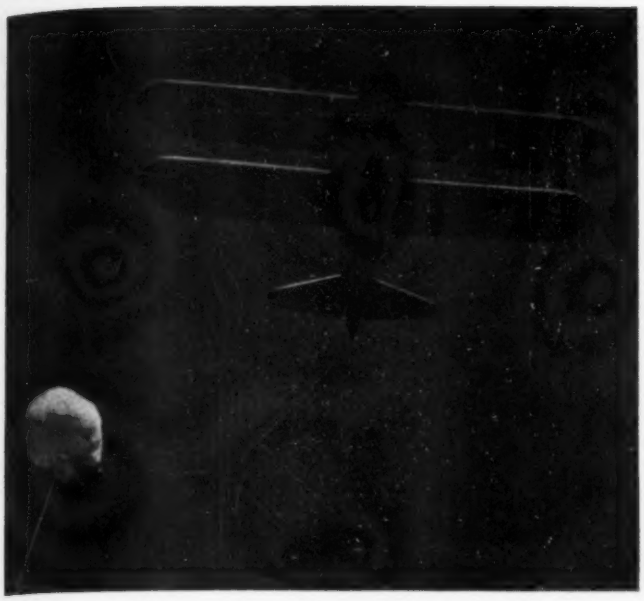
Observing the flight of a free balloon. Notes are being taken by the Laboratory worker on the left.

Feminine worker of the Signal Corps General Development Laboratory checking wind velocity measuring equipment.

closeknit and as air travel has come to be relied on to an increasing extent. As a consequence, great advances have been made in the theoretical analysis and practice of the forecasting technique. Signal Corps meteorological investigators have been closely concerned with these events, and it is well that they have been, for a correspondingly rapid development of the "tools of the trade" has had to follow. Only if instruments were refined and improved at the proper rate could full use be made of the improved technique. It was the function of the General Development Division of the Office of the Chief Signal Officer of the Army to provide the necessary funds to encourage development by commercial concerns guided by the Signal Corps General Development Laboratory.

The most picturesque of these modern meteorological "tools" is the radiosonde, which explores the atmosphere vertically for data on pressure, temperature and humidity, which it reports to the ground by means of a small radio transmitter. At the ground, the message is recorded and is plotted as a function of the time of flight. A counterpart of the radiosonde is the aerometeorograph which is borne aloft by a plane. The data which it records are evaluated upon the return of the plane to the ground.

The radiosonde is regarded as preferable to the aerograph for several reasons. It can go up and report on weather conditions high aloft on days of low ceilings, when the airplane remains grounded. These days, notably, are the ones when ascents are most needed. Of course, no hazard to personnel is involved when the radiosonde is used. Savings in time and cost—a matter of considerable importance as the demand for knowledge of the weather has so widely expanded—are produced by the use of it. Since readings are made automatically as the radiosonde climbs, no time is lost. The ground station equipment which receives data from the minute light-weight transmitter during its lofty journey is a permanent installation, the cost and upkeep of which are very low in comparison to these costs for airplanes. The radiosonde travels upward until it reaches atmosphere so rarefied that the balloon bursts. Then the meteorograph drops earthward, its return journey being eased by a parachute. A large pro-



Airplanes were used formerly for gathering weather data. Fog prevented daily flights.

portion of meteorographs sent into the upper atmosphere in this fashion are recovered and used again.

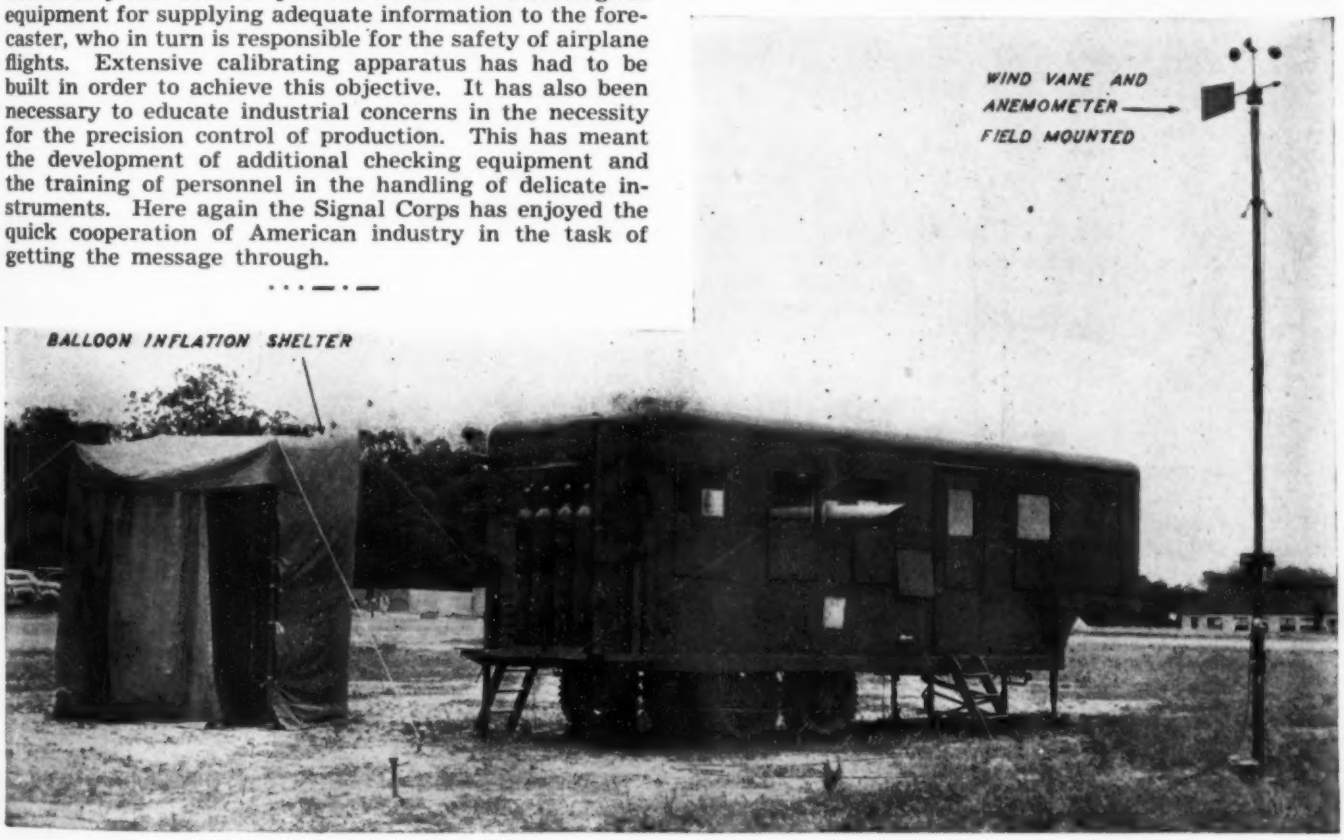
A large number of other instruments and techniques, of course, are under study and development by the Signal Corps. In the field of surface observation equipment, mobile warfare has shifted emphasis from fixed station observations to mobile weather centrals. To reduce the time of the transmission of consolidated weather teletype reports and the delay due to deciphering and plotting the reports, facsimile transmission apparatus is being used.

Other developments are under way whose nature cannot be disclosed until after the war. Suffice it to say that they have a bearing on gunnery, sound ranging, and forecasting techniques. Under the direction of Major General Roger B. Colton, and later of Colonel R. V. D. Corput, Jr., the objective of the Signal Corps General Development Laboratory has been to produce accurate meteorological equipment for supplying adequate information to the forecaster, who in turn is responsible for the safety of airplane flights. Extensive calibrating apparatus has had to be built in order to achieve this objective. It has also been necessary to educate industrial concerns in the necessity for the precision control of production. This has meant the development of additional checking equipment and the training of personnel in the handling of delicate instruments. Here again the Signal Corps has enjoyed the quick cooperation of American industry in the task of getting the message through.

. . . — . —

Women workers are very proficient in handling the many tasks at the Signal Corps Development Labs.

A complete meteorological station for field use. Balloons are inflated in tent away from wind.



Scoring a Quartermaster Corps Training film. Prepared lecture is timed to synchronize with film action.

Sound Recording of Training Films

This special branch of the Signal Corps prepares Training films on many important military topics.

by Col. M. E. GILLETTE

Born in Illinois in 1892. Graduate of Des Moines College, 1916; post-graduate work in journalism at Columbia University, 1931. Commanding Officer, Signal Corps Photographic Center, Long Island City, New York. Served during World War I with the Quartermaster Corps; assistant Quartermaster 7th Army Corps with the Army of Occupation. Organized and directed the first Training Film Field Unit at Fort Monmouth, 1937-1940, and during the next two years organized the Training Film Production Laboratory which was moved to their present location, the Signal Corps Photographic Center at Long Island.

LIKE other enterprises in our military effort, the production of training films by the Signal Corps is carried out by an organization which has undergone a tremendous expansion since pre-war days.

Training Film Field Unit No. 1 was the official designation of the original nuclear group of this expansion. From this single field unit with its valuable experience, the organization has grown until it now comprises a large studio force and many field units, with a commensurate extension of facilities.

In an effort to produce a large number of good training films as rapidly as possible, non-essential production techniques have been simplified or discarded. Hence as far as sound-recording is concerned, the available personnel and equipment have been extended to supply to the greatest number of pictures possible, the amount of sound considered to be essential to a lucid presentation of the instruction at hand.

To date, most films have employed an offstage narration running the length of the picture. This narrative follows closely the text of War Department Training manuals. Live sound and dubbed-in effects are used only when they enhance the effectiveness of presentation. To preclude any possible distraction from the subject at hand, music is used only on the main and end titles of training films. The narration, live sound, effects, and music are mixed in rerecording to produce a release negative.

Although an effects-library is maintained and constantly augmented, it is usually necessary to record effects to meet the particular demands of a picture. This is true since most of the effects used in training films must be strictly authentic. For example, the sound of a 75 mm field piece firing cannot be substituted for that of a 37 mm antitank gun, since each has its distinctly characteristic muzzle report.

One film for the Quartermaster Corps calls for the characteristic sounds of over twenty different kinds of truck motor knocks and noises, a bill which no ordinary effects library could be expected to fill.

So far as is possible, the equipment used is standardized as to cable connectors, line impedances, case and transmission grounds, compensators, mixers, and general channel set-up. This practice permits ready interchange of

Synchronizing sound and picture on moviola at Signal Corps Laboratory. This requires expert composition.

components as well as operating personnel, and minimizes the necessary replacement stocks. The equipment is divided into two functional groups, fixed studio channels and portable channels, with assignments of the channels being determined principally by convenience in meeting service demands.

In studio work with the fixed channels, all recorders, projectors, and cameras are driven with interlock distributors on 220 volt 3 phase a.c. When a portable recorder is used on a stage with camera, a 220 volt a.c. motor drives the recorder and the cameras are turned with an interlock distributor driven with a synchronous motor. Clap sticks attached to the printed slate are used for sync marks, with a spoken slate read before the sticks are hit. Some of the distributors are driven with regulated d.c. drivers, which do not necessarily run exactly at 60 cycle synchronous speed.

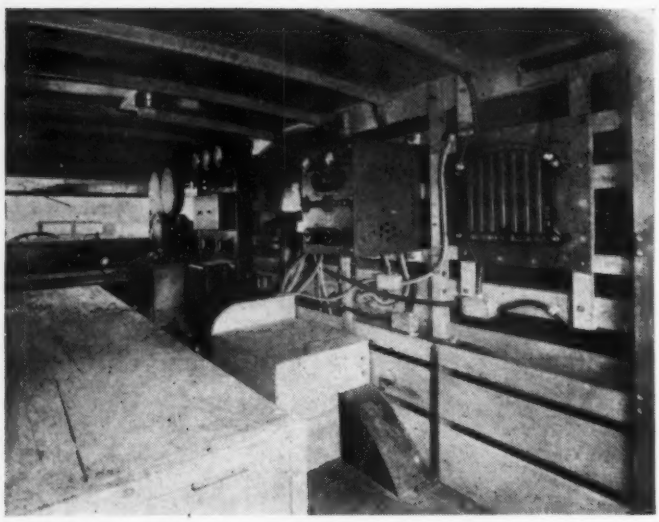
Both the distributor relay control lines and the motor lines appear on a patch bay, where any combination of recorder, projector, and camera motors and remote control boxes can be patched. This convenient arrangement was part of the original studio installation, as were also equally versatile monitor horn and signal light patch bays, a PAX Telephone System, microphone wall receptacles in the stages, and other features. Narration, both domestic and foreign releases, lip-synchronized dialogue in foreign tongues, are usually recorded with fixed variable density channels, with ribbon light valve recorders. In this work as with other stage pick-up, cariod type microphones are employed.

The microphone is mounted on a floor stand when recording narration. The narrator stands, and reads his copy from a music stand, the latter so placed and tilted, relative to the microphone, as to avoid reflection effects. Microphone booms with cueing heads, rubber microphone suspensions, and silent, braid-covered cables are used when shooting with camera.

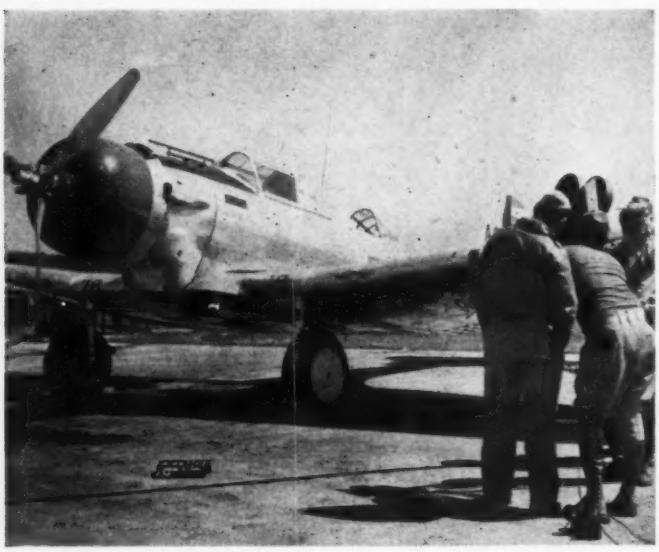
Signal Corps Training Film Field Unit No. 1, photographing details of foot bridge construction, Ft. Benning, Georgia.

Heart of the Sound studio—the monitor booth. Operator controls volume of sound as it is photographed onto film.

Sound Recording Power Truck of the Training Film Unit. The subject to be filmed is aerial machine gun fire on targets.



Interior of Sound Recording Truck at the Signal Corps Laboratory. All units are tied down securely to prevent damage.



Signal Corps Field Unit setting up their camera in preparation to the taking of sound film of airplane motor noise and action.

★ ★ ★

Shooting a scene showing how machine guns should be used in ground defense against low flying enemy airplane attacks.

The microphone feeds directly to an electronic mixer in a portable console. The console also contains an adjustable low frequency dialogue equalizer and a voltage amplifier which brings the signal up to bridging bus level, approximately zero db (0.006 milliwatts). The low frequency equalization compensates for accentuation of the lows due to microphone characteristics, selective room reverberation, difference in recording and reproducing levels, etc. Depending on working conditions and voices used, this equalization ranges from 5 to 10 db drop at 100 c.p.s. In some set-ups, the console is located on the stage and the signal is monitored with head-phones. In other cases, the console is placed in a monitoring booth where monitoring is done with a speaker. Regardless of where the console is located, the mixer has a choice of monitoring either the bridging bus input or a photo-electric cell pick-up of a portion of the light transmitted by the recording light valve. The shift is made by throwing a switch at the console. Also provided on the console are PAX telephone and signal light connections.

From the console, the audio signal goes to a main amplifier position, where it feeds a 500 ohm bridging bus. This bus is bridged by amplifiers supplying power to the light valve, a volume indicator, a monitoring circuit, a disc playback recorder, and a ground noise reduction amplifier. An 8 db noise reduction and 4 db margin are representative settings of the ground noise reduction systems. The light valves are tuned to 10,500 c.p.s. and the ribbons are spaced by 0.0005" and offset by 0.001". Clamped bridge valves are used on one machine. A 7500 c.p.s. low pass filter is inserted just ahead of the valve to reduce tube hiss and to prevent overloading of the valve at frequencies near its natural tuning point.

Recording is done in variable area duplex track with equipment of more recent installation. The recorders and rerecorders are located in a common room, where the recordist and rerecorder operators can work in close cooperation. The rerecorders are theater type soundheads, with oil damped rotary stabilizers, and are equipped to reproduce either "standard" or push-pull track, only the turn of a switch being required to change from one type to the other. Daily checks on the push-pull balance of these heads are made with 1000-cycle loops of proper azimuth, a cancellation of at least 30 db being normally maintained through adjusting the balance of potential on the anodes of the twin photocell.

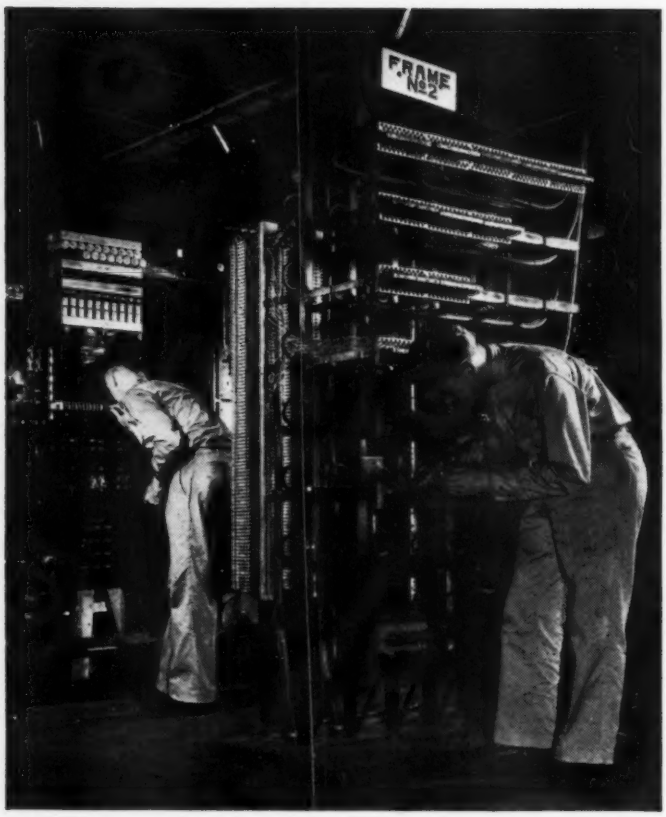
The 250-ohm transformer outputs of the sound heads are cabled to 45-db two-stage portable PEC amplifiers, mounted interchangeably by plug-in slides on an equipment rack in the same room. The outputs of the PEC amplifiers can be patched to trunks feeding mixer consoles in the rerecording monitor rooms. A fixed compensation for recording and reproduction losses at the higher frequencies is provided in a discriminating interstage coupling circuit in the PEC amplifiers. For further compensation in frequency balance or for effect, the rerecording mixer console is provided with adjustable compensators convenient to the mixing position. These rerecording compensators permit settings for various amounts of rise or drop at either the high or low frequencies, as well as various tilts of the frequency characteristic in both directions in the mid-range. The mixer may monitor the signal level with either a db meter or a neon tube volume indicator, both of which are bridged across the recording bus.

As he watches the projected picture work print for cues, the mixer monitors the result of his mixing over a standard two-way theater speaker system. The monitor circuit includes an equalizer with a proper high frequency droop to compensate for the PEC amplifier rise. Acetate discs are sometimes cut for immediate play-back with picture. The projector, film recorder, rerecorders, and disc recorder are, of course, driven in interlock. An amplifier with adjustable compression is used in rerecording, the compressor usually being adjusted for 2:1 compression in the 20 db range of compressor input below 100% modulation. That is, the output versus input curve breaks away from a slope of unity to a slope of 0.5 at a point 10 db below that compressor output level which

(*Continued on page* 150)

WIRE

Wire systems afford privacy of conversations and are not subject to interception with direction finders.



Students engaged in the task of soldering on large telephone rack. They must become thoroughly familiar with color coding.

Signal Corps student operating a field telephone test station. Tags identify various lines extending to many field divisions.

WIRE COMMUNICATIONS

by Maj. ROY O. FRANZEN

Born in Minneapolis, Minn., in 1904. Graduate of the University of Minnesota in 1925. Commissioned in the Signal Corps Reserve after completing four years' R.O.T.C. Signal Corps course there. Engaged in planning and development in connection with the manufacture of telephone equipment with Western Electric. Called to active duty at Headquarters of the then 2nd Corps Area in 1930. After two years with the New York Signal Corps Procurement District, called to extended active duty in December 1941, and assigned to the General Development Branch of the Office of the Chief Signal Officer.

FUNCTIONING side by side with radio, wire communication provides irreplaceable advantages in the business of carrying the vast number of messages necessary to co-ordinate supply and large troop activities in the prosecution of the war. The wire system affords privacy, personal contact between commanding officers, dependability, immunity to atmospheric static and to other interference. Furthermore, enemy intercept and direction-finding equipment faces a more difficult task against our wire communication. Radio and wire together carry the bulk of the work of putting the message through. This fact has made it imperative that new army wire equipment be developed to fit the pattern of modern warfare. It has also brought about a closer union of radio and wire units.

The Signal Corps hence must train in a very short time enough personnel to operate the equivalent of a big commercial system, scattered far and wide, which can be transplanted to any theater of operations on short notice. Moreover, it not only must train necessary operating personnel, but also must design, procure, issue, maintain and operate the system. Much praise must be given to the commercial communications companies and the designers and manufacturers for giving unsparingly of their time and effort to assist the Signal Corps in doing this man-size job in the short time allotted.

Basic Specialist Training is the first requisite for operating personnel, who must be familiar not only with wire usages but also with their precise tactical application in battle assignment. This Specialist training for wire communication is carried on primarily at Fort Monmouth, New Jersey, and at Camp Crowder, Missouri, where classes are conducted and tactical problems are simulated with the view of turning out enlisted men capable of doing the particular job in which they have specialized, together with officers who are capable of handling the broader phases of wire communications.

Other schools for wire communication are now also operating throughout the country. The American Telephone & Telegraph Company and associated operating companies are conducting a number of schools devoted to this study. Some idea of the demands to be met can be had from considering the need for *pole linemen*. About 15,000 of these specialists will be required within the immediate future. Their training course takes three months. At its conclusion they must be capable of installing poles, with their associated guying and hardware.

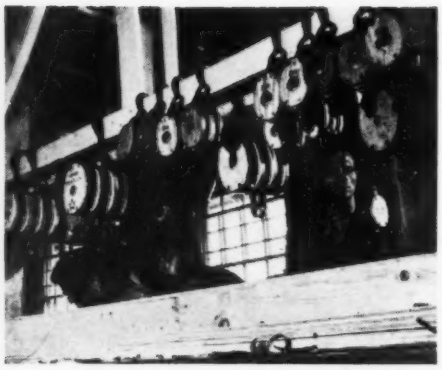
After assignment to a specific field unit, a man receives experience in the actual application of his specialty, and working as part of a team with other specialists is under-

This wire laying crew is making ready to string communication line from a Mobile Signal Corps wire truck. Wire crews operate in all kinds of weather.

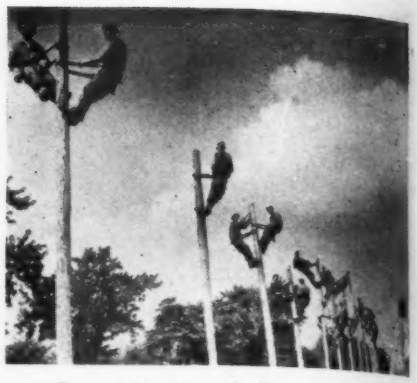
Construction truck equipped with derrick and mechanical "earth borer" used for erection of telephone and telegraph poles by the Signal Corps crews.

Soldier operating field telephone switchboard in heavily wooded section. Collapsible legs and compact construction make transportation simple.

Care must be taken not to damage insulators while stacking crossarms.



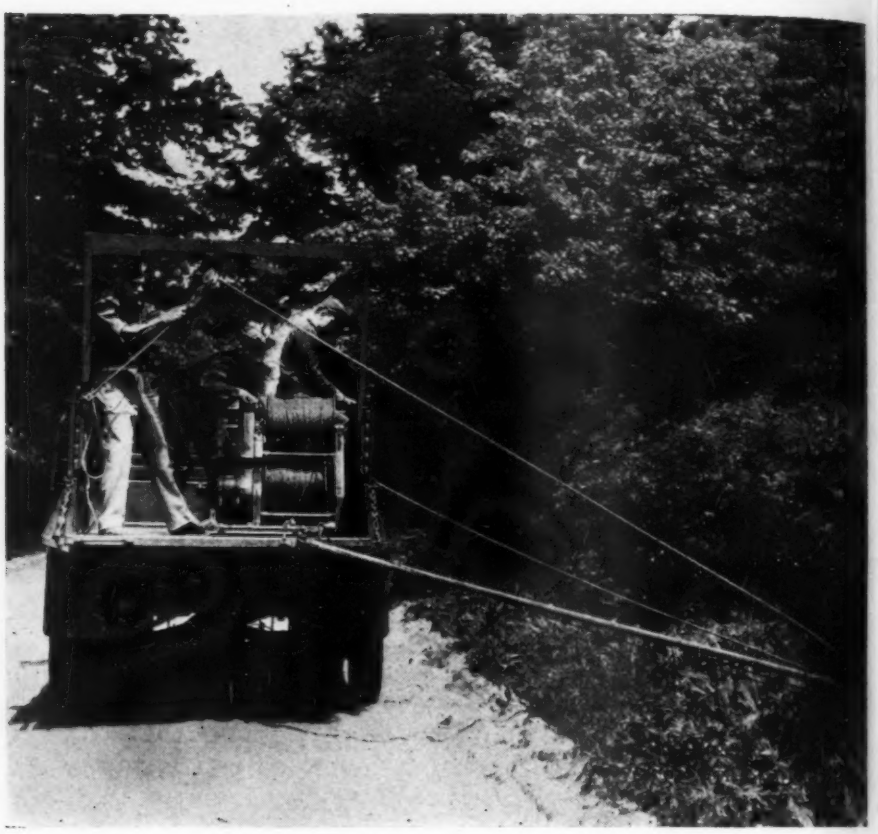
Students learning threading and use of various types of blocks.



Instruction in pole line construction at Signal Corps Schools.

Outpost field telephone straps around pole or other supports.

Servicing a wire reel cart used in stringing communication lines.



Thousands of feet of wire are fed out hourly by this moving truck.

scored. But this is only part of the wire specialist's job: Signal Corps troops must also be trained to defend themselves and maintain the offensive while performing their job—particularly in the case of line construction and maintenance personnel who must travel in small groups. To do so, these men and their vehicles are supplied with effective weapons which they must learn to use; the coverage and camouflage of equipment, lines, vehicles and tracks of the vehicles are also taught.

During the first World War long distance telephone communications were carried on solely at voice frequencies on open wire lines. Two-wire voice-frequency repeaters were the only means of long distance communication other than telegraph. The first carrier telephone system was placed in commercial use just at the close of the first World War and introduced means of greatly increasing the number of simultaneous telephone conversations which could be transmitted over a single open wire pair. In the twenty years since the close of that war, the carrier telephone art has made tremendous strides. Most of the long toll telephone traffic in the United States was transmitted over carrier telephone systems on open wire lines or cables.

The application of the carrier telephone art to military uses has been immediate with the advent of the present war. Wherever open wire lines have been found in place by our far flung forces, commercial carrier telephone equipment has been applied to increase the capacity of the lines already in existence. In some instances lines in excess of 2,000 miles in length are being so equipped.

Carrier telephony has also been made to fulfill the needs of tactical units in the theater of operations where traffic is likely to be heavy so that lines must be laid and placed into operation rapidly, where transportation facilities are at a premium, and where the distances over which communications are necessary are much greater than in any previous war. Equipment meeting these requirements has been designed wherein carrier telephony is applied to a light cable which can be laid rapidly and which will provide excellent telephone communication over distances of several hundred miles. In addition to supplying telephone communications, carrier telegraph is also transmitted over this cable, thus providing several channels of high speed printer telegraph service over much greater distances than was possible with d.c. telegraph. All of this telephone and

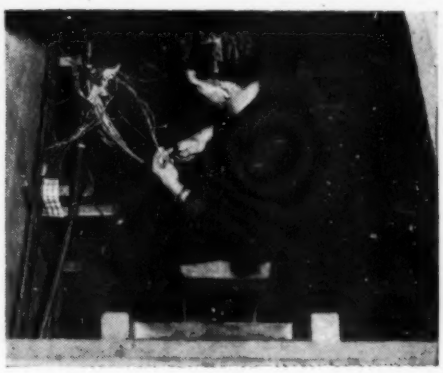
Ample supplies of cables must be available for field communication.

Radio directs the operations of the field crews. Note wire and reels.

Outdoor experience in cable repair and service at the Training Center.

Late type field telephone switchboard. Note dial above patch cords.

A Signal Corps lineman tying field wire in place prior to stringing.



Birdseye view of student at work in manhole making wire cable connections.

telegraph service is provided with a bulk and weight of material that is less than 5 per cent of that of the lightest type of open wire construction which would provide the same amount of service. Furthermore, by the use of carrier systems where several channels of communication are required it is estimated that over 3,000,000 pounds of copper will be saved in the next year.

Equipment has also been developed to act as terminal amplifiers and two- and four-wire voice frequency repeaters on single channel field wire lines so that as forces advance, existing lines can be extended and so that long local lines can be used. This equipment is approximately the same size as the field telephone and is powered only by dry batteries. Such repeaters as these must also function substantially without attendants and be capable of withstanding the rough handling that such a small package is very apt to receive.

One of the problems which confront the designer is that these repeaters must function over lines of sometimes very poor and widely varying electrical characteristics, since the transmission medium may be field wire laid on the ground, rubber covered cable, or open wire lines.

During World War I, a large portion of the Army wire communication system was of a somewhat permanent nature. Most lines were open wire, installed on poles obtained from Spain, using solid copper wire in accordance with commercial practices at that time. It is anticipated that this type of facility can also be utilized to some extent in this War. Line construction trucks equipped with earth borers, pneumatic tool equipment and derricks are being provided for this purpose.

Constructing such a wire line is a slow process however, and such lines are very susceptible to destruction, so that it has been necessary to provide other types of lines. As in the last war, field wire is still being used but with improved characteristics. Instead of the heavy outpost wire used in very advanced sectors in World War I, very light assault wire is being specified; it has a transmission range fully equal to that of the old wire but is very much smaller in diameter. A considerable quantity of what was known as outside distributing wire was used in World War I because of the lack of commercial facilities for producing other than a solid conductor. Lacking flexibility, this wire

(*Continued on page* 204)

DEVELOPMENT OF

by

Col. J. D. O'CONNELL

This heavily armored car awaits the oncoming enemy from a concealed position adjacent to a supply line.

Born in Illinois in 1899. Graduated from the United States Military Academy in 1922 being commissioned a Second Lieutenant of Infantry, transferring to the Signal Corps in 1929. Holds graduate degrees from Yale University. Studied communications engineering at the Sheffield Scientific School in 1929-30. Is a graduate of the Command and General Staff School. Executive Officer of the Signal Corps Laboratories at Fort Monmouth in 1929, and in the next year took charge of communications projects there. Col. O'Connell was assigned to the Office of the Chief Signal Officer at Washington in November, 1941.

Speedy scout cars are equipped with latest radio equipment. Tied-down antenna prevents whipping.

VEHICULAR EQUIPMENT

The success of Blitz techniques must depend upon adequate communications. Without them pincer movements would fail.

WHEN the British captured German General von Ravenstein at Tobruk a few months ago, they captured with him a pithy epigram. "Desert warfare," said the General, "is a tactician's paradise—but a quartermaster's hell." But the General made a serious omission when he forgot *Purgatory,* wherein resides the signal officer, sitting on pins and needles in everlasting fear of the failure of his communications. For, in this war of fast movement, failure of communications spells failure of the operation.

While increased emphasis has been placed upon all phases of signal communication, accounts, with few exceptions, have failed to do full justice to the fact that the success of German Blitz techniques of double pincer and "Kedge and Kessel" depended completely on adequate signal communications: without them any double pincer or similar tactic is doomed to failure from the start.

In the many apparently catch-as-catch-can combats which result from these tactics, it is basic that the side with the best communications will inevitably win—other factors being equal. Creating a condition of chaos in the communications of the enemy, while at the same time maintaining a full flow of information and control over our own forces, is much like a boxing bout in which one fighter has his eyes bandaged and his ears plugged, while his opponent has the full use of every faculty. You can imagine the odds in such a prizefight.

For this reason, ideals to be attained in signal systems for modern war are: (1) Perfect signal communication at all times and (2) Systems of such flexibility and mobility that the establishment and maintenance of communications does not impose limitations on the inherent mobility which can be obtained by daring and competent use of the airplane, the truck and the tank.

Of course, such signal systems include extensive wire lines which, working hand-in-glove with radio, form the flexible network of army communication. Wire adds advantages to the elasticity of radio: It provides personal contact between commanding and staff officers, offers privacy, and keeps our troops' location secret from enemy interception. Our wire communications will be treated further elsewhere in this issue. But in this article we're dealing primarily with radio which, under the difficult and kaleidoscopic conditions of modern war, calls for the most modern instruments our factories can produce. Production at once, and the full equipment of the army is, of course, of primary importance. But for the long pull, that, alone, is not enough: In the Signal Corps there's no such term as "good enough." Signal equipment must *all be better,* and as rapidly as it can be *made better.*

Therefore, our Signal Corps development agencies, on which this assignment falls, must not only take every advantage of knowledge gained by past experience, but must break through to new horizons of research and development. For the character of signalling changes with the character of every war. This is no exception: to signal maneuver the hordes of Genghis Khan waved black and white flags from the top of a hill; today a maneuver of U. S. troops may be instantly ordered through frequency-modulated radio by an armored vehicle racing at high speed.

To make our radio good, and a lot better than that of our enemies, is the objective of Signal Corps Development Agencies which, well before the beginning of the

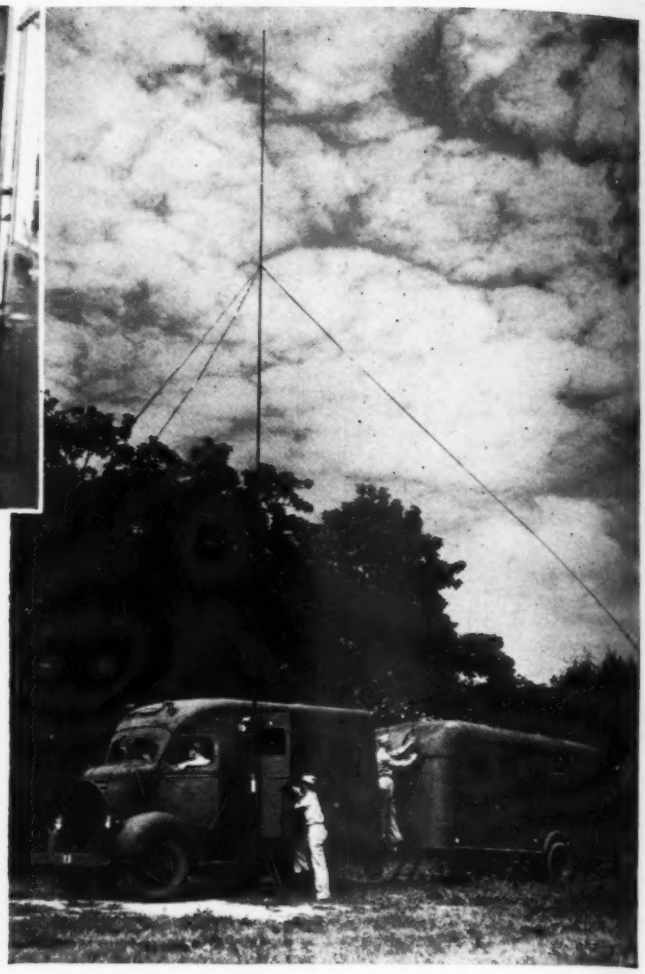
A crew of Troop E, 6th Cavalry, prepares to go into action. Radio keeps them in touch with other units.

Interior of latest trailer unit resembles a compact and efficient permanent installation. Everything is tied down.

Tank radio sets withstand terrific heat and vibration.

All vehicular antennae are equipped with spring mounts.

Highly maneuverable are these radio-equipped scout cars.



This mobile unit includes powerful transmitters and receivers (in trailer unit). Truck contains generators.

war, had embarked on a vigorous forward course. Long before Pearl Harbor was attacked, most developments had resulted in production contracts for modern radio sets.

The problem of radio equipment for this war was attacked simultaneously on several fronts. At our Laboratories, operations were divided among sections, each of which were assigned specific projects, and specialists on each subject were assembled. The knowledge of these specialists ranges over the entire front of engineering: design, development, research and radio propagation. Field tests, experimentation, and development were often conducted in parallel so that two or more sections worked on related problems at the same time, and one unit, making a useful forward step, communicated it to others.

An early and concentrated spearhead of attack was the development of tank radios, essential to co-ordinated action in battle. First presenting itself was the basic requisite that the tank radio should be *just as tough* as the tank itself and be able to withstand hammering encountered over the roughest terrain. The radio had to withstand mechanical shock and be tough to roughness in tuning and operation by men who cannot take time from the grim business of *getting the enemy first,* to conduct the niceties of dial twisting. Furthermore, our tank radios had to have range and reliability and had to offer dependable communication in any part of the globe where tanks might conceivably operate.

Many obstacles had to be met and overcome. The problems were complex: Ignition noise from powerful tank motors would blot out reception; roaring mechanical noise would render operators deaf to incoming orders; high-frequency vibration impacts from hard-surface roads would loosen tubes and break wires. Then, based on these requirements and knowledge, a development contract was placed with one of America's leading radio manufacturers,

Interior of scout car. The small compartment above the receiver holds a spare set of all tubes required for the radio equipment.

while the development facilities of his laboratories swung immediately into high gear. Off the laboratory bench, his first models were taken into the field for a gruelling series of service tests.

First the sets had to communicate over unfavorable terrain. Then they were banged and bounced as tanks slid into gulleys and over obstacles. They were roughly operated and put through many forms of abuse while their measure was taken. Then came other sets: improved models for additional service test. This part was changed, that one was removed, something else was altered. A wire here, a tube there. Once more, sets left the Laboratory bench to go into the field. New and old sets were operated side by side, in gulleys, behind hills, under the hum of high-tension lines when the tanks' guns were firing. Finally, their measure, also, was taken.

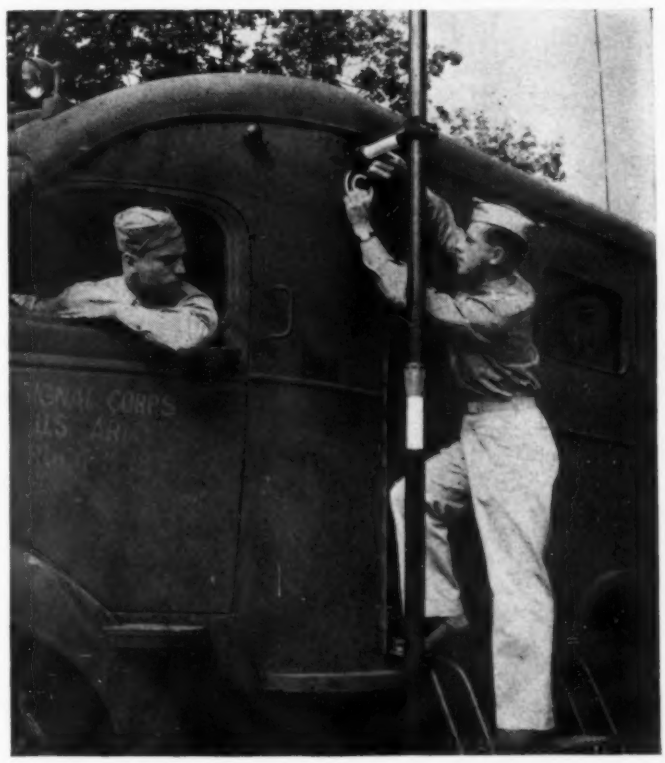
Out of this testing came a mass of factual data: Ideally suited to a tank's communication requirements were certain frequency bands, certain types of shock mounting, certain power outputs. Moreover, frequency modulation, used in a tank's radio, had stepped up its communication range 30 per cent; its intelligibility was 25 per cent more at mid-range.

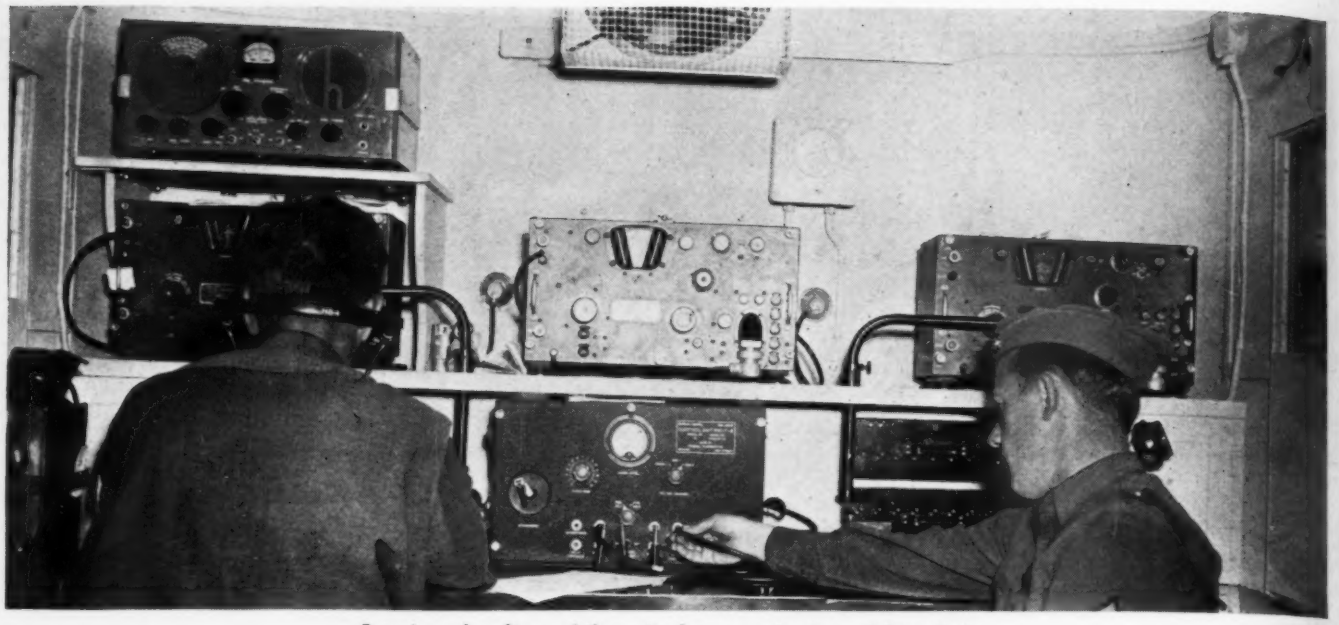
All this was only part of the work done by us and by the manufacturers: There were thousands of man-hours of drafting, checking, setting-up of test equipment, ordering parts, inspection tests and expediting delivery. These things had to be done carefully and done well to make possible the stream of tough, hard-hitting tank radios now coming off America's production lines. This is only one case among many—all of the available development facilities were similarly employed in the development of other items of Signal Corps equipment.

The development of yet another radio set, used in the

(*Continued on page* 198)

Transmitters in truck connect to vertical antenna through the bowl type insulator. Note sturdy supports.





Interior of radio mobile unit shows equipment of late design.

Military Radio Design

Signal Corps radio parts and finished units must be able to withstand any climate and perform at any temperatures.

Telephone sets must have clarity for intelligent transmission.

by Maj. JOHN HESSEL

Born in Grand Rapids, Mich., in 1908. Was graduated in electrical engineering from the University of Michigan in 1929 and received degree of Master of Science from the same institution in 1930. Became Radio Engineer in the Signal Corps Laboratories in 1931; Engineer in charge of Receiver Developments, 1937; Chief Engineer, Field Radio Section, 1940. Commissioned a Major in the Signal Corps, July, 1942. Member of Tau Beta Pi and Phi Kappa Phi, and Associate Member of Sigma Xi and Associate Member of the Institute of Radio Engineers.

THE engineer who designs military radio equipment is faced with problems quite different from those encountered in most other branches of the radio industry. In the broadcast receivers, for instance, the designer knows definitely the frequency band he is expected to cover. He knows that the set is designed to operate in someone's parlor where the temperature in the winter will be somewhere between 70 and 80 degrees Fahrenheit, and somewhat higher in the summer. He knows that the primary source of power will be the local power company's lines which, in general, will be maintained at the correct voltage within very close limits, and sufficiently exact in frequency so that he may operate a clock with the greatest assurance in its accuracy. Broadcast transmitters, too, are designed to operate under conditions under the control of the designer. In cases where temperature and humidity variations may be too severe, it is often easier to install air conditioning than to change the design of the transmitter.

With military radio, the problem is vastly different. The designer must assume that his radio set will be required

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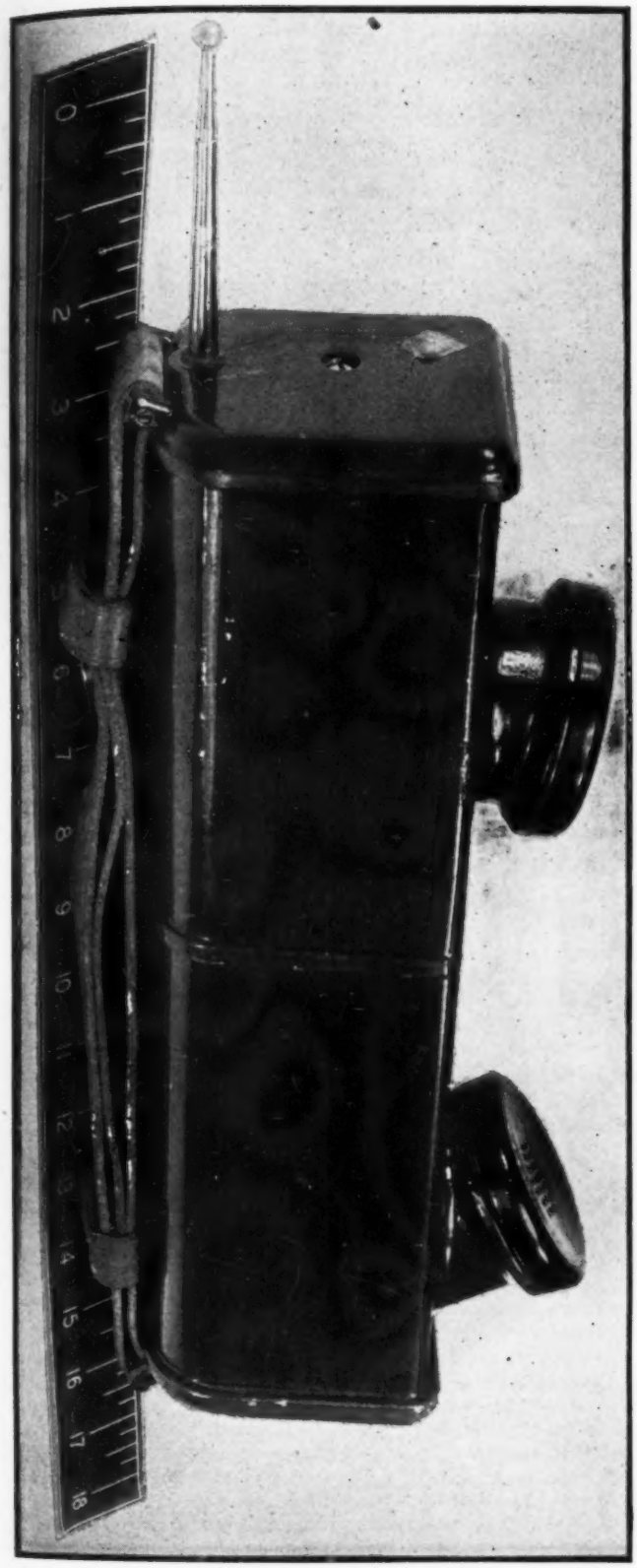
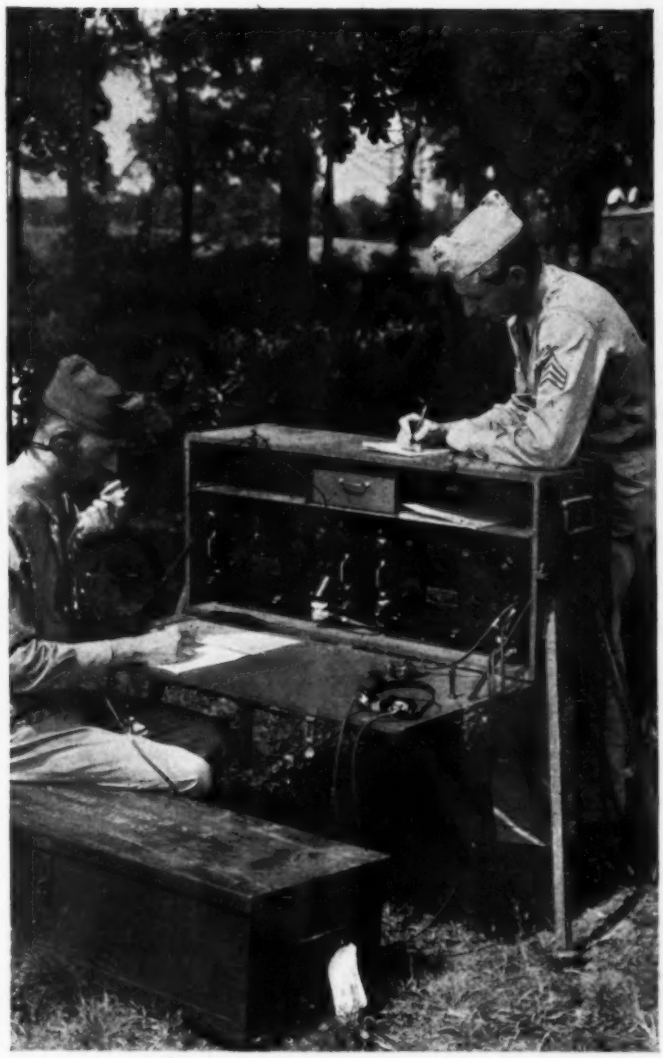


One of the most versatile of all radio equipment is the "Handie Talkie." Developed in the Signal Corps Laboratories—it is best suited for close range contacts. It is ultra-compact and weighs very little compared to its sister "Walkie-Talkie."



Field sets are so designed that they may be assembled and put in operation with but a few moments notice.

Special care in the design of radio equipment for our mechanized units is essential to insure performance.

Operating a "handie talkie" from a fast-moving jeep. This set is a development of the Signal Corps Lab.

LABORATORIES TO DEVELOP

Painstaking research on radio equipment for our Signal Corps make American fighters better equipped than their opponents.

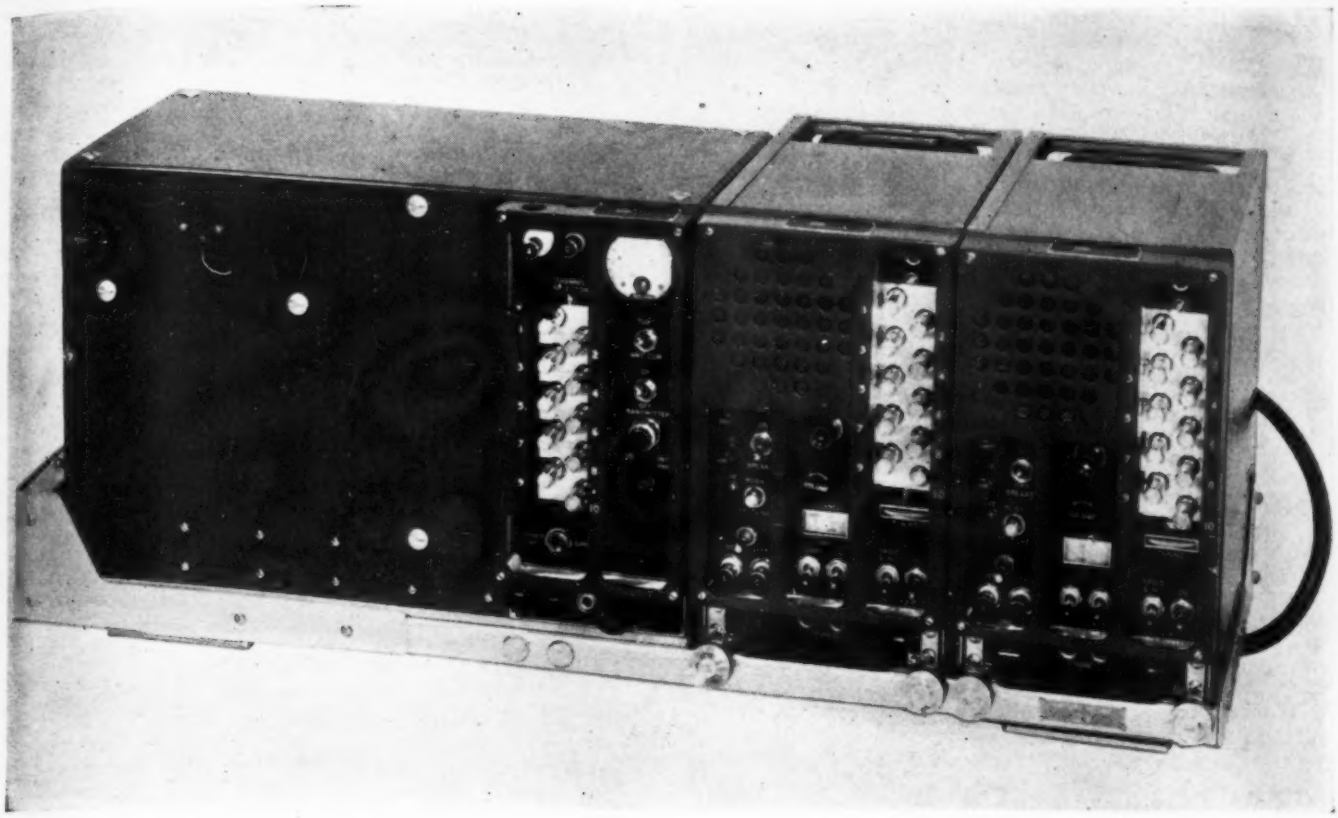
Born in Ohio in 1906. Graduated from the United States Military Academy in 1930, and commissioned a Second Lieutenant in the Signal Corps. Promoted to First Lieutenant in 1935, to Captain in 1940, and to Major in 1942. Postgraduate course in communication engineering at the Ohio State University with M.S. Degree in 1936. Graduated from the Signal Corps School in 1937. Present duties: Executive Officer, U. S. Army Signal Corps General Development Laboratory.

IN THE January issue of RADIO NEWS, Major (now Colonel) R. V. D. Corput described the Signal Corps Laboratories giving a brief outline of its history and its organization. Since then, the Signal Corps Laboratories have been divided into two separate organizations, one of which is the Signal Corps General Development Laboratory.

In the ensuing period, the General Development Laboratory has grown considerably both in physical size and in the functions and duties which it is expected to accomplish. The employees now number about 7000, and the plant has been increased tremendously in size. Under the new army organization, the General Development Laboratory operates under the Materiel Division, which is a part of the Signal Supply Service. The latter operates directly under the Chief Signal Officer of the Army.

The General Development Laboratory is concerned with the development of radio, wire, sound, and light equipment used for communication purposes in the Ground Forces; meteorological equipment primarily for the use of Artillery and the Air Forces; and radio direction-finding equipment for many different purposes. Various auxiliary equipment such as remote control devices, coding and decoding equipment, all types of power supplies, facsimile equipment, quartz crystals, microphones, and headsets are also the subject of research at the General Development Laboratory. An extensive program has been instituted for the development of substitute materials to replace items which, because of loss of sources of certain raw materials, have become very difficult to get. A tremendous reduction in the requirements for such essentials as aluminum and rubber has already been made, and research aimed toward still further reduction of the use of these supplies is under way.

Although the General Development Laboratory carries on some research which pertains to general means and methods rather than specific equipments, a great majority of its work is the development of equipment which has immediate practical use in the armed forces. As might be inferred from this fact, the basic idea and request for development of a particular radio set, telephone or similar item usually originates with the prospective user.



A frequency-modulated tank set developed by the famous Signal Corps General Development Laboratories.

FINAL VICTORY...

By **Maj. F. F. UHRHANE**

The first step in the initiation of development is a statement of "military characteristics." These include a complete non-technical description of the qualities which the equipment must include in order to satisfy a particular military purpose. They usually start by giving a general description of the item desired, with particular emphasis on the proposed use. Such things as maximum allowable weight, size and shape, range desired, power source, and means of transportation are then detailed. Finally the desired accessories and other special features are described.

These military characteristics are usually formulated by the service test board of the particular fighting arm involved. However, army regulations provide that any one may initiate military characteristics and it frequently happens that the basic idea, if not the formal military characteristics, is presented originally by the operators themselves or by the communication sergeants.

The military characteristics are then forwarded to the War Department for approval. If the equipment required is found to be sufficiently necessary to warrant development and the undertaking is technically feasible of development within a reasonable period, the Commanding General, Services of Supply, then directs the Chief Signal Officer to proceed with the development. Funds having been allotted, the General Development Laboratory proceeds with the experimental advancements.

This may take one of several possible courses depending upon which may offer the greatest advantages as to speed of development and delivery of production quantities to the ultimate user. As a general rule, the development is done by an industrial organization under contract to the General Development Laboratory. Every possible effort is made to choose organizations that may be expected to have adequate manufacturing capabilities for the article in question once the development has been completed.

In some instances, a development is started by engineers in the Laboratory and is brought to a rough breadboard model stage. This model is then taken to a commercial organization with a contract to produce a limited number of finished service test models which may also be expected to serve as manufacturing samples. Either of the above courses of action results in the eventual delivery to the General Development Laboratory of a limited number of models designed to meet the complete requirements of the military characteristics.

After a preliminary test at the General Development Laboratory, the models are taken to the prospective military arm and there are given a thorough field test by the users with the assistance and cooperation of Laboratory engineers. As a result of these tests, the models may be either approved, disapproved, or approved with exceptions. The latter result is probably most frequent.

Upon approval of the test report, the War Department establishes the basis upon which the equipment will be eventually distributed, and the General Development Laboratory is directed to furnish complete procurement information in order that quantities may be ordered incorporating any modifications which have been agreed upon. After the tooling up period which is required in the manufacture of this sort of equipment has elapsed, deliveries to the military arm begin.

In many cases, a completely new development is not required but relatively minor alteration of the existing

equipment may be sufficient. For example, an Infantry communication sergeant may recommend an improvement in the dial of a radio set based on his own experience in its operation. If his immediate superiors agree his idea has merit, his recommendation is eventually forwarded to the General Development Laboratory through the Chief Signal Officer. Here his idea is reviewed, the field and technical considerations are weighed, and usually one or more sets are modified to incorporate the suggested changes. Circumstances permitting, the sergeant may be ordered to visit the General Development Laboratory for a brief period to consult with Laboratory engineers regarding his ideas. If the changes seem to be desirable from a technical standpoint, the Laboratory then considers the effect the changes will have on production. In some cases, it may be possible to incorporate the improvement in production with relatively little difficulty. Quite frequently this is not the case, and it becomes necessary either to postpone the change for incorporation into future models of the same set or to file the idea for reference when a complete redesign of similar sets become desirable.

The General Development Laboratory is currently engaged in doing certain types of work which are not strictly developmental in nature, although they have generally arisen as a result of research which was started originally in the Laboratory. An example of this is the static suppression in automotive vehicles, tanks, and armored cars of many kinds which are used by the Ground Forces.

All of these vehicles now in production are being suppressed or shielded to eliminate the propagation of radio interference by their electrical systems. This work has become increasingly important during the past two years because of the vast increase not only in the number of vehicles employed but in the number of radio sets. Technicians from the General Development Laboratory are currently engaged in applying suppression systems to motor vehicles in this country and abroad. As the new types of radio sets are delivered to the troops in the field from the manufacturers, the General Development Laboratory also sends out groups of engineers and technicians to assist in their proper installation and to instruct the maintenance and repair crews in their maintenance.

Until recently the manufacture of piezo electric crystals has always been on a small job basis in which the individual crystals were manufactured from start to finish by one or two persons. Tremendous quantities of the new type of radio sets now produced for army use are crystal-controlled. This fact has necessitated a very great expansion in the crystal industry with a complete change in manufacturing methods. The General Development Laboratory has accordingly been actively engaged in investigation and development of techniques adapted to production-line manufacture of crystals. A considerable amount of research and test of gasoline driven power plants to provide power for the newer types of radio equipment has also been necessary.

Numerous other projects and activities, all of which have a direct bearing on the supply of modern technical equipment to the fighting man in the field, are being pushed to the utmost at the Signal Corps General Development Laboratories in order that the American soldier shall always be better equipped than his opponents.

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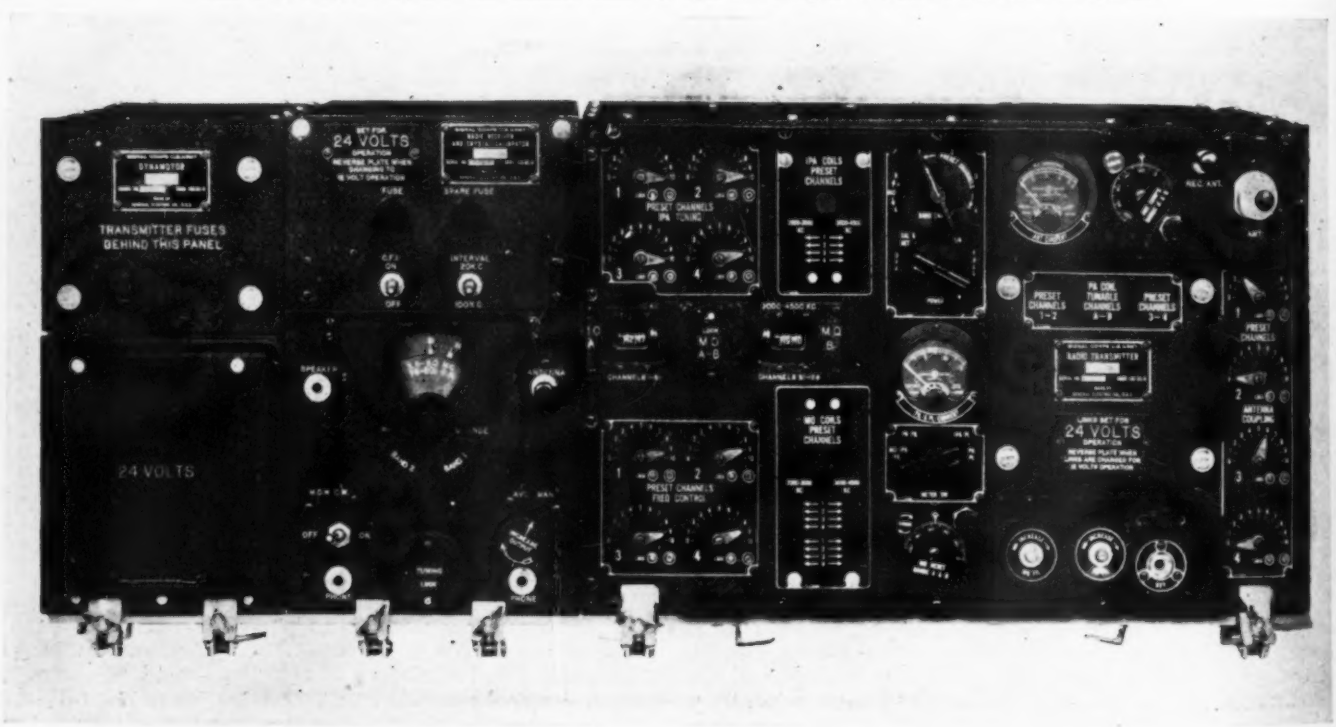
Mechanical and electrical problems must be met in the design of compact long-range field equipment.

This long range amplitude-modulated tank set operates in spite of terrific vibration in combat.



PROCUREMENT

The Signal Corps Procurement branch supplies in excess of 60,000 different items to the Armed Forces.

by Col. E. V. ELDER

Born in Arkansas in 1895. Attended the University of Kentucky and entered Federal Service with the Kentucky National Guard in 1917. Became a First Lieut. in the Signal Corps in 1920, promoted to Captain in 1934, to Major in 1940, to Lieut. Col. in 1941, and to Colonel in 1942. Graduate of the Signal School at Fort Monmouth and of the Army Industrial College. Studied in the Graduate School of Business Administration, Harvard University, 1934-36. Service includes command of the Hawaiian Branch Area Signal Depot at Honolulu and the post of Supply Officer of the Hawaiian Signal Depot, duty at Fort Monmouth. Now in Office of the Chief Signal Officer.

WORLD WAR II, more than any conflict in history, is a war of communication. The first intimation of Japan's treacherous attack upon Pearl Harbor came when a private in the Signal Corps, using a complicated device, detected the approach of the enemy's bombers. It is more than probable that the final note of the present global struggle will be sounded on Signal Corps communication equipment which is today becoming the nervous system of the United Nations, the cohesive element which has merged the far-flung democratic fronts into one solid anti-Axis bulwark.

Wherever the blows for freedom are being struck there you will find some of the 60,000 different items of equipment furnished by the Signal Corps to the armed forces of the Allies. The Air Forces, the Infantry, the Coast and Field Artillery, the Cavalry, the Ground and Parachute Troops—in short, every branch of the U. S. Army carries with it communication and detection apparatus procured from American manufacturers by the Signal Corps. And whether it's a telephone jingling in the field headquarters on the Russian front, an impassioned orator on a Chinese radio station, the orders of the commanding officer coming in on an oven-hot American tank on the Egyptian desert, or the furtive courageous signals of a free Norwegian's or Yugoslavian's hidden transmitter, it is all the same message of freedom getting through, and it is probably getting through on equipment furnished by the U. S. Army Signal Corps.

Aircraft, vehicular, and portable communication equipment, airborne and ground radio—these, and field wire, and such wire communication apparatus as telegraph and telephone instruments, switchboards, sound and flash ranging equipment are the major categories of Signal Corps equipment in the present war. Since each U. S. military airplane, excepting certain trainer craft, is equipped with at least one type of communication radio set, or with radio compasses, interphone equipment, and other devices, and

This trailer and accessories are examples of the many types of equipment purchased by the procurement division.

Headsets, microphones, keys and thousands of other radio items must be supplied to our many military forces.

Various antennae for all types of fixed and portable sets must be tested and furnished for the Signal Corps.

Test equipment must be purchased for use in the hundreds of classrooms within the many training centers for radio men.

since radio beacons, power units, meteorological devices and many other items are employed with aircraft, the demand by the Signal Corps for antennae, headsets, microphones, tubes, receivers, transmitters, and batteries is obviously great.

If to this is added the radio equipment for tanks and other armored vehicles, the portable and ground radio sets used in conjunction with all sorts of military operations, and the elaborate radio apparatus needed for mobile and stationary detection and locating installations, then it may be realized how far a cry it is from the distant day in 1859 when Major Albert J. Myer, a physician keenly interested in communications, was designated as the Army's first Chief Signal Officer.

For at that time smoke signals, lanterns, hollow-tree drums, crude semaphore flags, and a few homing pigeons characterized the art of transmitting messages through space. Even telegraphy was in its early infancy. Now, however, the catalogue of the items of Signal Corps equipment reads like an inventory of man's most extraordinary inventions. Semaphore flags and pigeons may still be found, but in addition there are all the scientific and technical implements which have resulted from many years research into the communication, photographic, meteorological, and radio sciences. Modern Signal Corps equipment ranges from the simplest type of glass insulator on a telephone line, or from a pair of lineman's gloves to a complete 100 kilowatt broadcasting station or a complex protective system.

The radio industry, of course, supplies the most important portion of Signal Corps requirements. This is in sharp contrast to the last war when the telephone, telegraph and electrical industries provided the major facilities and much of the military and civilian personnel. While the telephone and telegraph are still profoundly important, and while most of the physical volume of equipment purchased by the Signal Corps is not radio material, well over 90% of the dollar volume of the Corps in recent years has been for the procurement of radio equipment.

Since July, 1940, when war production began in earnest, appropriations have increased very rapidly. Already under contract are Signal Corps orders for equipment totalling many times the value of the entire American radio industry's output for the year 1941. But these figures, conservative as they are, are apt to be misleading unless it is noted that the average unit cost of a piece of military radio equipment is many times the cost of domestic apparatus. Some idea of this difference may be gained from consideration of the fact that the average vacuum tube used in a home radio had a wholesale price of approximately 25 cents, whereas the average non-commercial tube used by military sets costs considerably more. Millions of such tubes are now on order.

Vehicular radio items must be unusually well built. The procurement officers see that equipment is of the best.

Tubes by the thousands must be ordered for the Signal Corps and other services. Many types are now employed.

Peacetime procurement of Signal Corps equipment, looking back from the vantage point of the present, was relatively simple. Fewer items were required, and naturally far fewer quantities of any article were ordered. Nonetheless, the Procurement Division of the Signal Corps had to plan for mobilization day. Such planning took place over a period of twenty years. With the co-operation of a few large manufacturers whose laboratories, experience, management and research staffs were placed at the Army's disposal, the Signal Corps was long engaged in the development of equipment of which large quantities would be needed when, as and if war struck. More than 1,000 plants and factories were surveyed and appraised by Signal Corps representatives to determine the nation's capacity for the production of signal apparatus.

Procurement procedure was standardized to facilitate the tasks of prospective contractors. Procurement Districts and contracting offices were established in various parts of the country. The structure of the Chief Signal Officer's organization was streamlined in anticipation of the prodigious detail which war time procurement would involve.

As a result of these measures, the declaration of war on December 8, 1941, found the Signal Corps already putting into high gear the machinery it had so patiently created.

Large orders for equipment were placed at once. Many of them were naturally given to those firms that had acquired the tools and skill for rapid, large-scale military production in the quiet peace years. But there was only a handful of such companies. Most of the more than 50 home radio set makers continued to turn out civilian sets, until such production was halted. And even many of those firms which were willing and anxious to embark upon war production frequently found that the special technical and speed requirements for military equipment ruled them out until they could add to their equipment and skilled personnel.

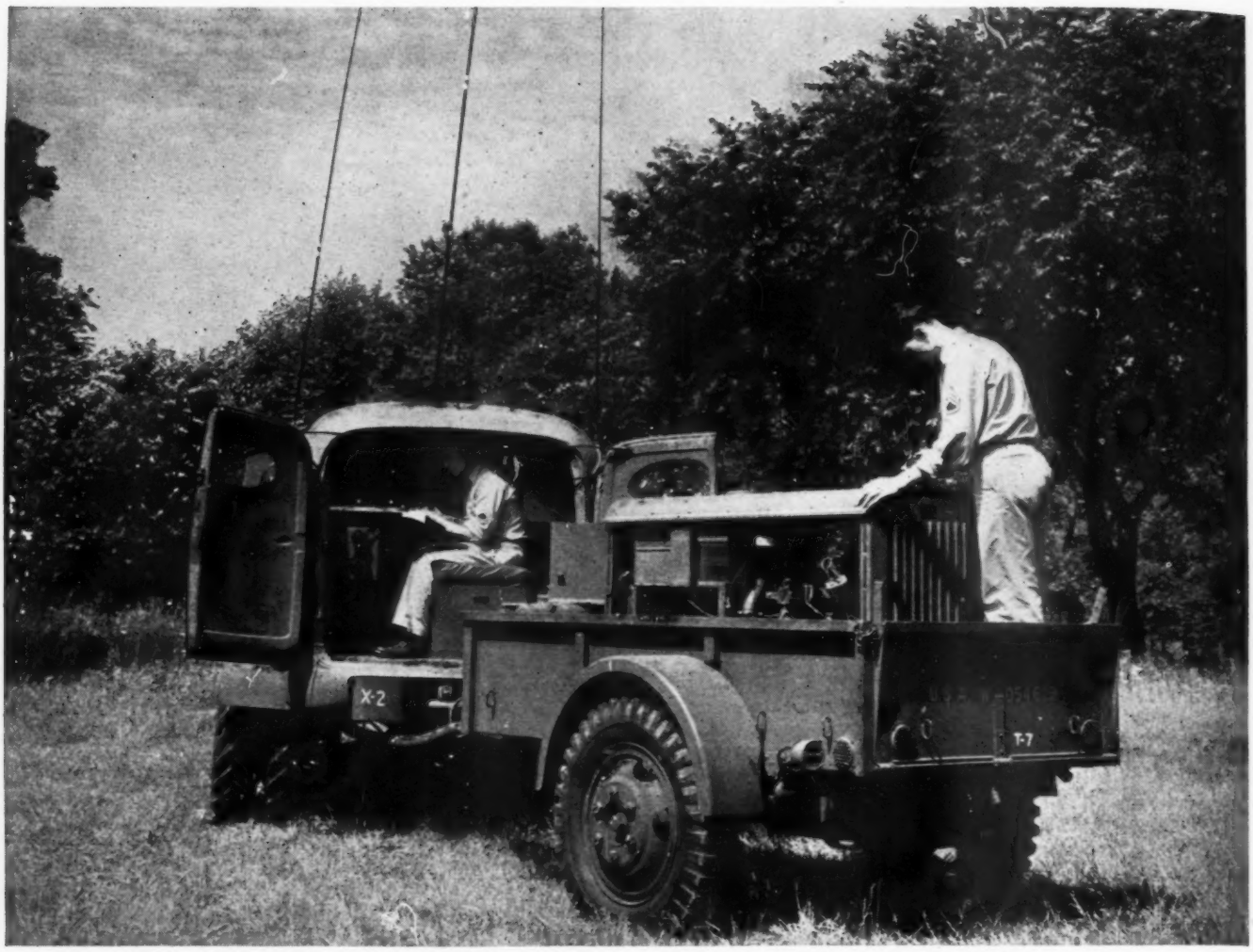
Much of the industry had been devoted primarily to home receiving sets. There was relatively little transmitter production capacity, and yet transmitters were particularly required for the war effort. Finally, most radio factories were essentially assembly plants and were not equipped to engineer or develop new ideas and complicated production problems.

Thus, at the beginning of the war effort, there existed the parodoxical situation of a plant shortage amidst an apparent wealth of facilities. The solution of this problem was the principal objective of the Chief Signal Officer at that time. Some plants already engaged in work for the Signal Corps were expanded. The course usually adopted, however, and since then pursued on an ever-widening scale, was to require the large contractors to subcontract

(*Continued on page* 214)

Tanks are equipped with special transmitters and receivers which must withstand terrific punishment.

Purchasing equipment is no easy task. This is a part of the Storage and Issue Division in the Munitions Building.



Many members of the Army Amateur Radio System operate mobile units such as this truck and trailer unit.

The AARS FIGHTS

Members of the AARS are experienced radio ops. This famous organization is of great value to the Signal Corps.

by Capt. ROY D. JORDAN

Actively interested in amateur radio since 1920, when he took out his first call—9ALI. Still holds W2KUD, and is a Class A operator who expects to go back to pounding brass after the war. Graduated from the University of Wisconsin, 1927. With General Electric Company until being called to duty in the Office of the Chief Signal Officer, having been first commissioned in 1927. During many of the last 20 years active in ARRL affairs, winning the Schenectady Amateur Radio Association Award of Merit in 1940.

NOT so many star-filled nights ago, the lights went out in thousands of "shacks" across the length and breadth of these United States—winged out one by one as countless others have faded throughout the world. But let no enemies of United Nations take joy or comfort from either that humble word "shack," or from this particular national blackout! For "shack," preceded by the word "radio," no matter how elaborate or humble it might have been, was peace and heaven to nearly 65,000 licensed radio amateurs and, equally important but innumerable, radio experimenters and short wave listeners. And the "shacks" are dark and deserted now because their owners have a bigger job to do and there's little time for play.

Chapters could be written around the individuals who in khaki or Navy blue, took one last look around the old shack—then flipped out the lights; books will be written some time about the en masse exploits of the radio amateur and experimenter in World War II. But this is only the chronicle of one specific group—the upward of 5,000 members of the Army Amateur Radio System—and, for obvious reasons, it can at best be only a review of the growth of this organization, and an analysis of its potentialities in this all-out effort for victory.

In its swaddling clothes of spark coils and oat-meal box receivers, amateur radio was but a lusty infant when Uncle Sam beckoned back in World War I. But the great value of the "Ham" as a source of radio operators was quickly demonstrated then when about 3,500 joined up.

Receiving instructions over Walkie-Talkie for the operation of a 75mm. gun during Army Maneuvers.

Immediately following World War I an attempt was made to organize the radio amateurs of the United States into an Army Amateur System, but it was not until 1924 that the Signal School at Fort Monmouth, New Jersey, recommended that such a system be organized and a Board of Officers was ordered to get together with the officials of the American Radio Relay League at West Hartford, Connecticut, and work out a plan of organization and operation. This plan—patiently worked over and revised to eliminate "bugs"—was approved by the War Department on September 28, 1925, and with this official blessing the newly-created AARS went to work.

The initial membership of the AARS was small—about 300—and its growth was slow—for obvious reasons. Although the plan aroused much enthusiasm among the radio amateurs who were willing to do their part, the lack of funds and personnel prevented the Signal Corps from giving proper attention to the organization. As was to be expected, many amateurs soon lost interest in the AARS and resigned. Something more timely—so mething more within the ken of the average amateur—w s needed to make the AARS "click."

That vital something was introduced when a revised plan was put into effect on January 1, 1929. This revised plan emphasized as its prime objective cooperation with the American Red Cross in connection with disaster relief radio communication, in place of the original purpose of creating a reservoir of trained radio operators for use in a national emergency. After all, war was mighty far away back in the 20's—except as something to look back on! Here then, in the revised plan, was something almost every amateur could get his teeth into—something close at hand, and imminently possible. And, more and more, the radio

(*Continued on page* 156)

Former members of the AARS are in great demand as operators and instructors in the Army Signal Corps.

ARMY SIGNAL SERVICE

Laying emergency cable under fire. Walkie-talkie operator gets instructions from rear.

Vast Communications networks are employed by the Signal Corps and include a host of operational duties and various techniques.

by

Lieut. Col. WILLIAM D. HAMLIN

Born in New York, 1905. Enlisted in the Army as a private in 1924, and in 1925 was selected for admission to the U. S. Military Academy, graduated and commissioned a Second Lieut. in the Signal Corps in 1929. Promoted to First Lieut. in 1934, to Captain, 1939, to Major, 1941, and to Lieut. Col., 1942. A graduate of the Signal Corps School. Studied communications engineering at Harvard University. Service included duty in the Panama Canal Zone, at the Signal School at Fort Monmouth, and as Assistant Signal Officer of the Third Army. Ordered to Washington in 1941 and was assigned to the Office of the Chief Signal Officer.

THE vast and varied work of the Signal Corps in developing, improving, and procuring the many different instruments used for military communications has really one primary purpose. If that purpose is not carried through, all the careful planning and hard work in headquarters, factories, procurement districts, and so on, go for naught. That purpose is the establishing of swift and accurate communications services for armies in the field. Such an undertaking obviously is one of many phases and many difficulties. It is so big that it could not be explained in detail in any single article, even if considerations of military secrecy would permit the attempt. But a good over-all idea of how the Signal Corps goes to work on this job in the field can be shown. And as basis for it we may well use recent Army maneuvers, in which the techniques of modern warfare were carried out as in a laboratory experiment. In it, men of the Signal Corps put the message through, establishing Army signal service in the field under conditions very closely approximating those which they will encounter in actual combat.

When the Third Army Headquarters was permanently organized as a tactical organization, troops were assigned from various sections of the country. At the time they reported, the big job appeared to be the activation of new units, organizing along sound lines, and the promulgation of training.

Shortly afterward, however, rumors started that great maneuvers were in the offing. These rumors were confirmed early, and planning for the maneuvers was started. The complexity and hugeness of such an undertaking from the start occasioned difficulty in visualizing the giant communication problem involved.

The troops which were to participate in these maneuvers, outside of the Divisions, were of classifications hardly spoken of in peace time, as we seldom had such units. Some of them were: Anti-Tank Battalions, Evacuation Hospitals, Field Medical Laboratories, Quartermaster Battalions (light maintenance), Ordnance Ammunition Companies, Surgical Hospitals, Quartermaster Railhead Companies, Salvage Collecting Companies, Veterinary

This lineman is ascending tree where he will make an overhead wire crossing. This job requires great skill.

The crew on the ground is laying the cable in its temporary position. Later it will be strung in tree.

Companies, Bakery Companies, Engineering Pontoon Companies.

When it is recognized that approximately 400,000 men took part as the Third Army portion of these maneuvers, and that they were spread over an entire state, the hugeness of the undertaking can be realized. Many problems immediately arise, such as how to feed, equip, and control this immense number of men. The problem in which the Signal Officer was primarily interested was that of control, because communications enter into control to a very large extent. In other words, a communication system is necessary in order that a Commander may transmit his orders to his subordinates. It happened that the major portion of the maneuvers was to be held in a sparsely populated section of Louisiana, in which established means of communication were extremely scarce. Therefore, the first requirement to be met was that of installing communication facilities. Quite early it was determined that Lake Charles, which is in the southern portion of Louisiana, was to be the main headquarters. Although there were communications to the east and west from Lake Charles, communication facilities to the north were scarce; and to the north was where the major portion of the maneuvers were to take place.

Facilities of the Southern Bell Telephone Company and the various independent telephone companies in the vicinity were used to the utmost; but because of the construction of the new Army posts in the central portion of Louisiana, existing facilities were taxed to the limit. It was, therefore, realized that additional facilities must be installed. Here the vision and experience of a qualified Signal Officer became readily apparent. General S. B. Akin, who is now General MacArthur's Signal Officer, took over the job as the Signal Officer of the Third Army about three months before maneuvers started. His foresight in visualizing the problems ahead played an important part in the successful planning for adequate communications.

When final plans for the maneuvers were made, it was found that the service area, which contained all the service troops, such as Motor Repair Parks, Supply Depots, Repair Depots, and such, covered an area approximately twenty miles wide and thirty to forty miles long. Spotted here and there about the area were numerous installations which were to furnish service to the ten divisions doing the fighting, and it was necessary that all of them have reliable communications. All agencies of communications were used in furnishing this service. Radio nets were established; wire communications (including teletype, telephone, and telegraph) were used; pigeons were used quite extensively; messengers (both in vehicles and in airplanes) played a very important part.

In the use of radio, many problems were presented. First, the operation of such a large number of radio sets in such a limited area was difficult. Hundreds of radios were used, and the problem of frequency assignments was a major one. This was finally solved by the assignment of frequencies only to nets of major importance; i.e., first consideration was given to organizations which from a practical point of view could use no other type of communication.

Motor messengers had an extremely hard job. Some of the routes covered by the messengers were one and two hundred miles long. When the heavy traffic on the roads is considered, the problem is obviously difficult. There were cases where messengers took thirty-six to forty hours of continuous driving and searching in order to deliver messages. Much of this driving was done at night, and in the forward area it was done without lights. In many cases the unit to which the messenger was going moved

Communications are vital to the success of any operation. Even gas attack cannot halt the process of laying cables.

After cable is put fast in position and circuits are ready for test, these men go into action. Note portable phone set.

★ ★

Mobile telephone units play an important role in our many applications for communications. This is a field message center.

while he was enroute, and he really had a problem in finding its new location.

Airplane messengers were used quite extensively during daylight hours. Light cub planes were used for this purpose, and were soon dubbed "grasshoppers." They flew at quite low altitudes and landed on vacant lots and on highways. On a number of occasions the skill and courage of these grasshopper pilots were taxed to the utmost as they were forced to take off and land in unusually hazardous surroundings.

In maneuvers, as well as in combat, troops must be ready to move at a moment's notice. The forward command post which was the nerve center of the maneuver was kept well in advance of the main troops. The installations which went to make up this command post were mounted in large horse trailers. In one particular case, orders were given to move and open up by daylight at a place about thirty miles away. Detachments were immediately sent out, and on this particular night, the weather was extremely bad. The new command post was to be set up in a small country town, which was really nothing more nor less than a cross road. There were, however, a few houses in the vicinity. During the night these big horse trailers started moving in, and men and officers were wandering around in the rain, falling in ditches and mud holes, attempting to find a place under cover for their installations. It is necessary, when setting up command posts of this nature, to hide them as far as possible from aerial observation. Therefore everything must be concealed. When daylight came, about thirty of these horse trailers were to be found all over the town, in people's front yards, in the driveways, and in every other conceivable place.

In the meantime the communication system had been established, and by daylight the troops had telephones and were able to talk to units located fifty or sixty miles away in addition to having access to all long distance facilities of the telephone company. Concurrently with the move of the forward command post the rear echelon establishment at Lake Charles was moved sixty miles to Eunice. This required the physical movements of tons of depot stocks and the establishment of an entirely new communication system.

When radio sets are used for communications in the field, too high frequencies cannot be employed because of the effect of skip distances, and relatively low frequencies must therefore be relied upon. Nightfall brought tremendous static increases in this particular area; and it was found that radio was almost useless after about ten o'clock at night. Bursts of static were so terrific and so constant due to the storm that it was practically impossible to interpret the message. One evening in a trailer containing a 300-watt transmitter which was working with similar equipment about fifty miles away, it was necessary to relay a message of about twenty-five or thirty words. An experienced operator, who was formerly a ham, worked on the message for two hours before he could get it cleared. When he got through, he could hardly hear because of the deafening effect of the static. Incidentally, this speaks well for ham perseverance. In many cases, in order to maintain the radio communication, relay stations were used which merely stood by when communications were good, but entered in as soon as going got tough. This procedure worked very well. Although in one or two cases the relay stations were practically surrounded by enemy troops, they had concealed themselves well and were never discovered.

Another very interesting phase of the communications was the use of teletype. Both private line teletype and TWX service were used and worked very satisfactorily over some extremely poor circuits. When one considers the delicate balance which it is necessary to maintain in order to operate this type of equipment, one wonders how it could ever be kept working under the difficult conditions imposed in the field where lines are being broken and grounded and moves are frequently being made. Only by the most careful maintenance at all hours and in all

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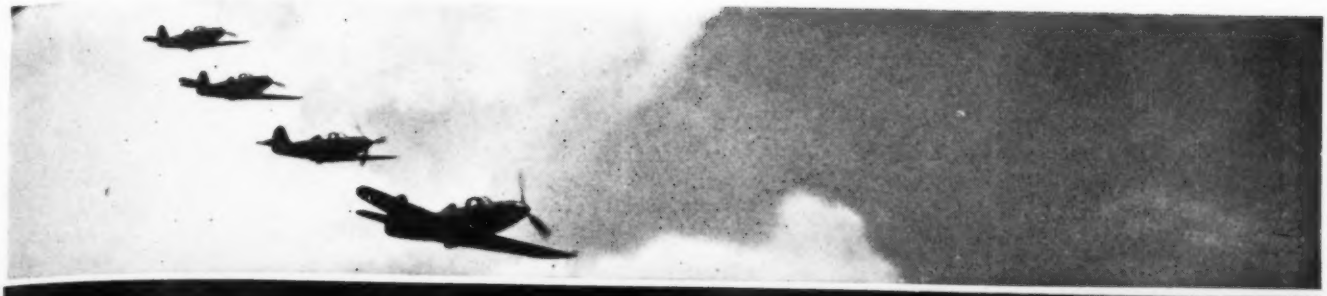


AVIATION RADIO

Only by efficient radio nets is it possible to coordinate the air and ground forces in combat.

Student at Randolph Field calling tower to get "all clear" before taking off on routine flight.

AVIATION RADIO

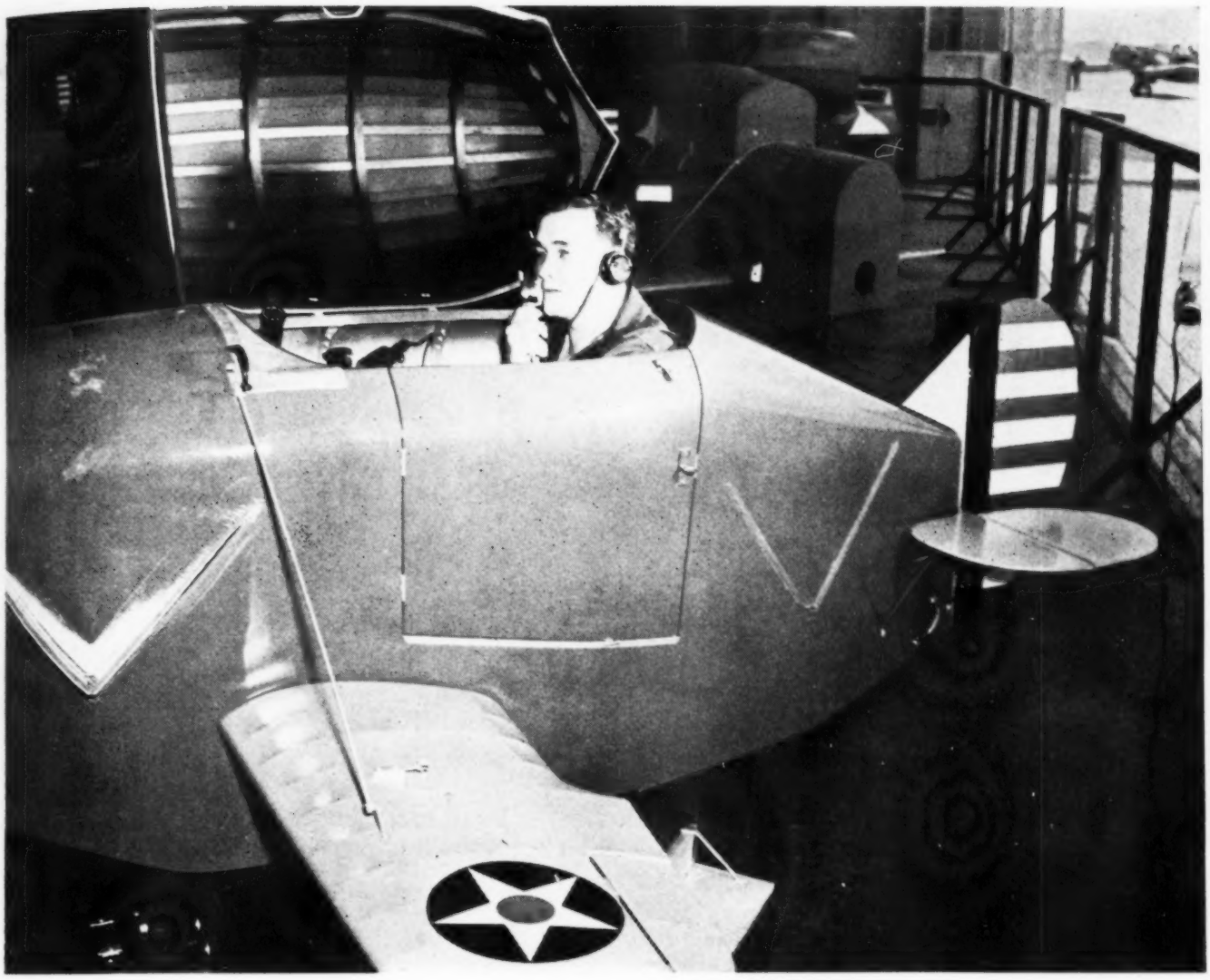
by Col. HOBART R. YEAGER

IN World War II, air operations play a dominant role. But this is also a radio war. Increasing emphasis is being placed on the use of radio airborne and ground communication, navigation, and detection devices. We do things with radio we wouldn't have dreamed of two years ago, for by means of radio, one airplane is enabled to perform a tactical mission requiring the use of several airplanes not so equipped.

At Wright Field, Dayton, Ohio, the Signal Corps and the Army Air Forces have organized the Signal Corps Aircraft Signal Service to handle all research and development, procurement, inspection, storage and issue of aircraft radio and ground radio used for navigational purposes. Placing these activities under one directing head and locating them at the Materiel Center at Wright Field means that red tape is slashed, the closest coordination is maintained with the Army Air Forces, engineering and procurement work smoothly together, all resulting in more efficiently meeting the needs of the Army Air Forces for aircraft radio.

Specifically, the Aircraft Radio Laboratory is charged with all research, development, engineering, and inspection incident to design, procurement, and installation of radio equipment in aircraft and of ground equipment for radio navigation. In actual practice, projects are set up and funds are allotted by the Chief Signal Officer in accordance with the wishes of the Commanding General, Army Air Forces. The Laboratory may do research on these projects, but in general most research is carried on in cooperation with the National Defense Research Council or is let on contract to the laboratories of commercial radio and electric concerns. The development, i.e., the adaptation of the radio device to perform a definite tactical function is closely supervised by the Laboratory. Also, such matters as

Director of the Aircraft Radio Laboatory, Wright Field, since April, 1942, after serving for two and a half years as Chief of the Navigation Unit of the Aircraft Radio Laboratory. Graduated from the U. S. Military Academy in 1918, transferred to the Air Corps in 1921. Served in the Philippine Islands and at various Air Corps Posts in the United States. Graduated from the Air Corps Tactical School in 1938, and from the Command and General Staff School in 1939. Holds ratings of Command Pilot and Combat Observer.



Future pilots receive training in communications on equipment designed by the Signal Corps Laboratory.

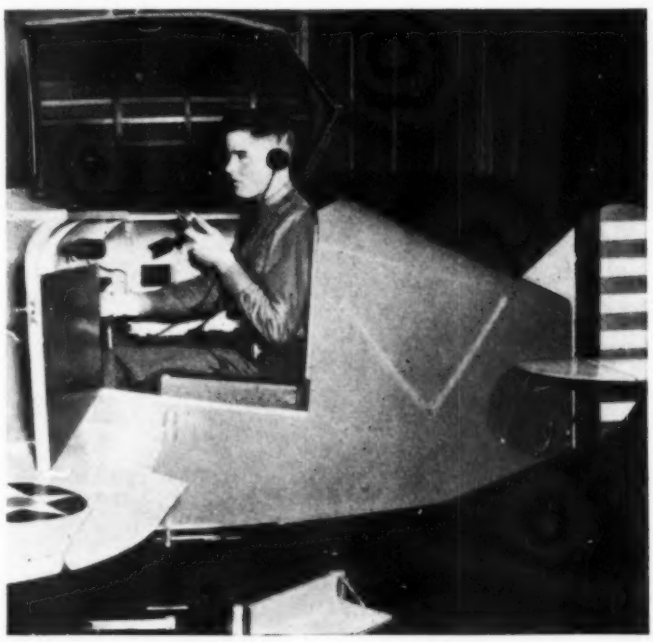
weight, power requirements, and form factor must be considered to facilitate installation in Army Air Forces airplanes.

Army airplanes are operating in all parts of the world from the frigid temperatures of Alaska to the tropical climate of Africa. Extensive tests hence must be made to make sure that radio equipment will give satisfactory operation under all conditions of altitude, temperature, and climate. These tests include thorough flight tests in order to determine the performance of equipment in the air and also to locate and eliminate any "bugs" which may develop. All equipment is required to meet the rigid requirements of the Army Air Forces which include extreme temperatures, high altitude, 90 per cent humidity, stringent electrical and mechanical tests, and finally, extensive flight tests of the equipment.

After the equipment has passed all tests, the Laboratory prepares the necessary pertinent information for quantity procurement. It has its own inspectors at the manufacturer's plant to see that the radio set meets the specifications. When the first production articles are delivered, the Laboratory makes a mock-up on various types of airplanes. In the mock-up the equipment is actually installed, and flight tested, and blue prints of mounting frames, brackets, and wiring diagrams are prepared. This information is then supplied to the appropriate airplane plant, modification center, or depot as a guide for similar installations on service types of airplanes.

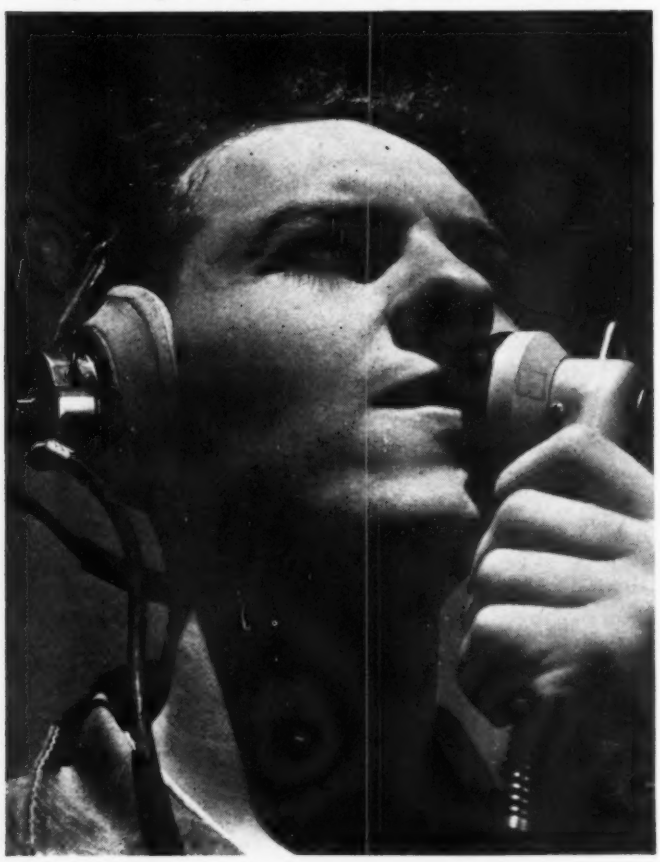
The Aircraft Radio Laboratory is assigned joint projects to work on in cooperation with the other laboratories of the Experimental Engineering Section, Wright Field. It is

The "Link Trainer" is radio-equipped. Students are taught to fly by instruments in this famous gadget.



Pilots would be at the mercy of enemy aircraft without unfailing radio contact with their squadron.

Special close-talking microphones have been developed by the Signal Corps for use in aircraft and vehicles.



necessary that close liaison and coordination be maintained on these projects. This joint work is generally done on the development of devices a part of which is electronic, the electronic development being the responsibility of the Aircraft Radio Laboratory.

Considerable research has been done in connection with the reduction of radio noise on airplanes. Conduit has been eliminated from Army airplanes, and greater ease of maintenance of the electrical and radio circuits, a saving of aluminum at the manufacturer's plant, and a considerable saving in the man-hours necessary for the fabrication and installation of the old conduit have resulted. Filters are employed to reduce electrical and radio interference at the source. Some shielding is still necessary on the high tension and generator circuits. This work is being carried on in cooperation with the Equipment Laboratory of the Materiel Center.

Since every pound of aircraft radio means a reduction in the weight of the useful load of an Army airplane, the weight of such equipment must be reduced to a minimum. It is also necessary to consider the form factor of such equipment in order to make its installation and maintenance satisfactory. The weight of radio equipment will vary with the size of the airplane and its tactical use. The larger airplanes generally carry more complete and comprehensive equipment; in single-engine fighters space and weight available, limit radio equipment to the absolute minimum.

Shortages of certain strategic and critical materials have made it necessary to conserve on these materials in the manufacture of aircraft radio and in some cases to make substitutions. However, no decrease in general overall performance and in reliability can be tolerated, since the operation of the radio equipment may easily determine the success or failure of the tactical mission and may be absolutely vital for the safe return of the crew and airplane.

In recent years more emphasis has been placed upon the ease of operation in the air with push-button remote control operation both for the transmitter and receiver, even

though these reqiurements call for more highly skilled maintenance on the ground. Since the radio operator is also a gunner, actual operation under the stress of combat must be as simple as possible. Every airplane carries a command set which is operated by the pilot and is used by him for navigational purposes and also for sending and receiving messages pertaining to tactical control of the flight. This set is generally operated on telephone and must have simple control because the pilot cannot be expected to fly an airplane and operate a complicated radio set at the same time.

The design of antennae becomes increasingly important with the new high speed airplane. In order to reduce antenna drag, the antenna must be as small as possible and must be streamlined. Usually the size and location of the antenna is a compromise based upon the drag which can be tolerated and the locations on the airplane structures which are available. Considerable flight testing is necessary to determine the antenna patterns.

The Aircraft Radio Laboratory has pioneered in the development of the automatic radio compass which is now standard equipment on all bombardment and transport airplanes. This device makes navigation easy on routes where ground direction finder stations are available. The pilot has an indicator calibrated from zero to 360 degrees, zero being the heading of the airplane. To "home" on a radio station, the pilot keeps the needle of the indicator on zero. To take side bearings, the desired radio station is tuned in and the needle swings automatically and points towards the station, indicating the bearing between the heading of the airplane and the airplane station line. This compass eliminates 180-degree ambiguity—the needle swinging to the rear when the airplane passes over the ground radio station.

Working in cooperation with the Navy and the Civil Aeronautics Authority, the Laboratory has effected a coordination of instrument landing facilities. It is highly important that the Army, the Navy, and the Airlines adopt the same instrument landing system in order that all agencies can use both Army, Navy, and commercial airports on blind landings. These facilities are fixed at the larger commercial airports and military bases and operated on remote control from the airport control tower. Portable facilities are also being procured for use at advanced airdromes.

The Laboratory has also worked closely with the Civil Aeronautics Authority in the development of ultra-high frequency radio aids to navigation. Operating in the ultra-high frequency spectrum we get away from thunderstorm static and rain, snow, and dust static. Army airplanes are now being equipped with sets to operate in this band. Since radio transmission is line of sight a certain amount of secrecy is obtained for military communication.

In crder to provide adequate civilian personnel to meet the increased wartime activities of the Aircraft Radio Laboratory, it has been necessary to go to extraordinary lengths to secure and train engineering personnel. The peacetime source of supply of Junior Engineers, i.e., graduates from colleges of electrical engineering, has practically disappeared in view of the demands of the armed services for this personnel, in either a commissioned or enlisted status. As a result, the Aircraft Radio Laboratory has engaged in extensive school training activities intended to provide engineering personnel. A streamlined 24 weeks of intensive study, comprising the bare essentials of an electrical engineering college course, is now in effect at eight Midwestern colleges. The students enrolled in this course are high school graduates with some college training or commercial radio experience which will provide the necessary background for the studies involved in the course. The first four colleges conducting this engineering course graduated their students in September, 1942. These men thereupon reported to the Laboratory for assignment as Under-Engineers to assist in development work in progress. It is anticipated that the program will provide a supply of personnel sufficiently trained to be of some definite assistance to our wartime program.

In addition, the Aircraft Radio Laboratory has in opera-

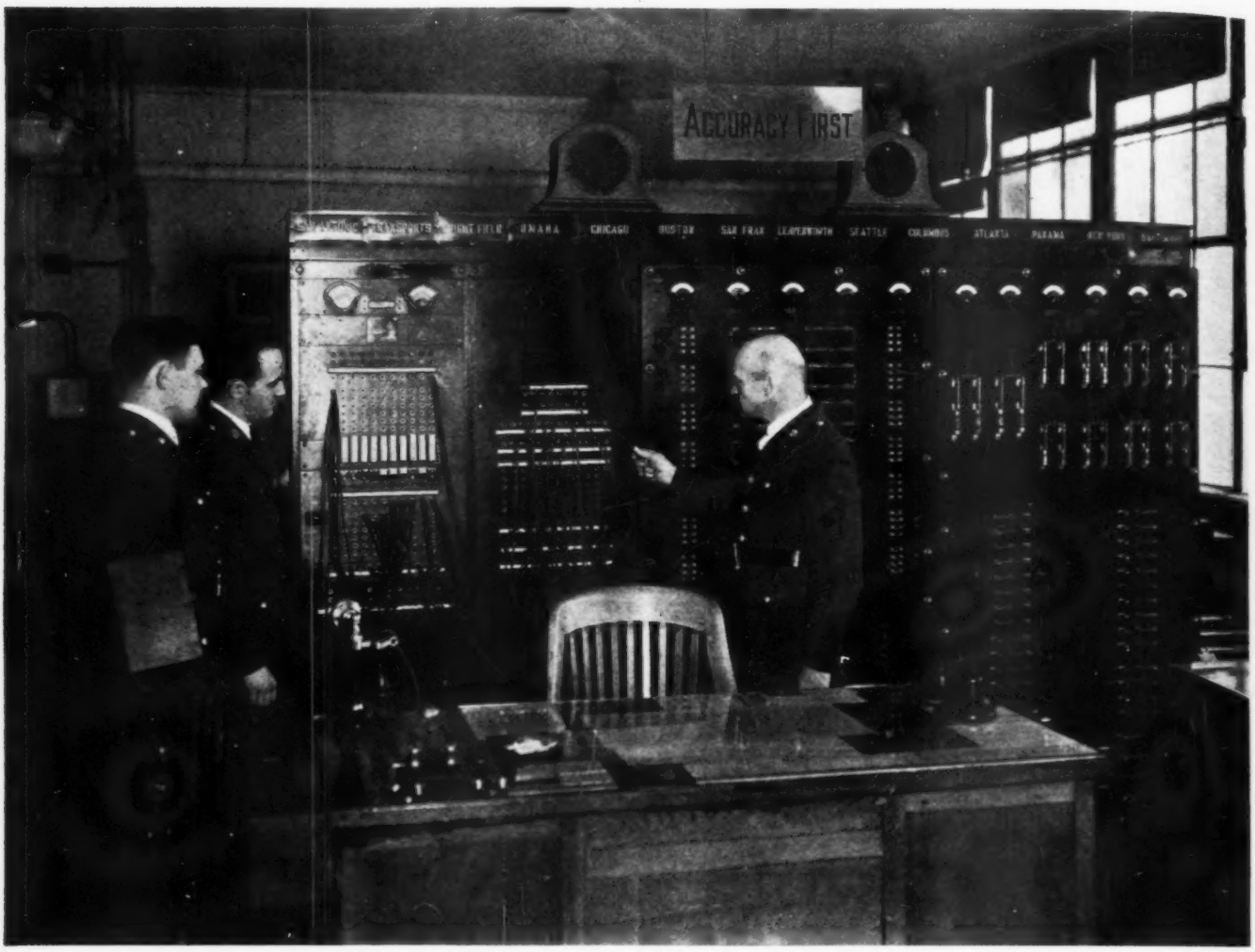
(*Continued on page* 202)

This Peruvian Officer will receive radio instruction with his other subjects at the "West Point of the Air."

★ ★ ★

This Argentine student is learning to direct traffic from control tower at Randolph Field, Texas.

☆ W-A-R AND THE



Master Control Board at the Army Signal Center in the Munitions Building, Washington, D. C., in 1934. Patch cords undergo inspection.

by Col. EDWARD F. FRENCH

Born in California in 1891. Attended St. Mary's College. Commissioned a 2nd Lieut. in the Signal Corps Reserve in 1917. Promoted to 1st Lieut. in 1919. Commissioned a Captain in the Signal Corps of the Regular Army in 1920. Promoted to Major in 1937, Lieut. Colonel, 1940, and to Colonel in 1942. Received the Silver Star citation for gallantry in action in the vicinity of Montfaucon. Ordered to Washington as Officer in Charge of the War Department Signal Center. Then in August, 1941, became Officer in Charge of the Traffic Division, Army Communications Service, in the Office of the Chief Signal Officer.

Only top operators are capable of handling the traffic which passes through the elaborate networks of the War Department Radio System.

MILLIONS of words a week speeding by the most modern radio and wire facilities of the communications art, thousands of messages daily being rushed to all areas of the globe by systematic use of manual and high speed visual recording, radio-telegraph equipment, radiotype channels, and teletypewriter networks—this in sum is the work of the War Department Radio Net system, developed and operated by the Signal Corps through its Army Communications Service. To make special wire communications network service available to the War Department and other government agencies is also a responsibility of the Signal Corps. This is met in the main by government-owned installations, by the leasing of facilities, and when necessary by the utilization of existing commercial systems.

The War Department Radio System consists of the War Department Radio Net and the Service Command and Department Nets. Station WAR, with transmitters and receiving station in one of the Southern States is the control station of the War Department Net, which was established on a small scale in 1923. The headquarters of the nine Service Commands and of the departments at

NERVES OF WAR ☆

This view of the War Department Signal Center, located in the Munitions Building, Washington, D. C., shows efficient layout of control installations.

Honolulu, San Juan, P. R., and Panama are all parts of the War Department Net, and each of these headquarters stations in turn serves as the control station for its own local net. The War Department Net necessarily has been greatly expanded in recent years, as the demand for getting the message through has extended over more and more of the earth. Today more than 300 stations are included in the Army's networth serving the United States and its possessions.

The circuits of Station WAR feed into the War Department Signal Center in Washington—central bureau where the messages of the War Department and some fifty other government agencies are handled. Thousands of messages dealing with the administration of the Army, changes in personnel, orders for the movements of troops, purchase orders for clothing, equipment, and other necessities go through the Signal Center every day. Operation of the Signal Center is a responsibility of Major General Dawson Olmstead as Chief Signal Officer of the Army. The Traffic Division of the Army Communications Service —one of the four Services into which the Signal Corps is divided—handles the actual operation of the Signal Center. The Signal Center is in truth the nerve center of the vast communications system of the Army, which covers the United States, Alaska, and Puerto Rico, and also extends to Hawaii, the Panama Canal Zone, and, more recently, to our leased bases in Greenland, Iceland, Bermuda, and the West Indies. Direct channels have been established in addition to other areas where armed forces of the nation are engaged.

The Signal Center, then known as the War Department Message Center, was established in the Office of the Chief Signal Officer at Washington on March 23, 1923. The War Department Radio Net was at that time in the early stages of consolidation, for first steps toward the organization of it had been taken a couple of years before. Radiotelegraph stations were installed by the Signal Corps during 1921 at most of the Corps Area (now Service Command) headquarters, with a master control station in Washington. Smaller stations in addition to these principal ones were established at many military posts and camps, mainly to provide communications facilities in the event of an emergency. By the end of 1922, about 72 stations were included in this War Department Radio Net. Seven years later, the number had increased to 212, and the network then covered practically all Army posts, connecting them to their respective Corps Area headquarters which in turn were connected to the War Department at Washington through the net control station whose call letters then were WVA.

Of course, as the urgent demands of global war have increased from day to day, requiring more and more

This is control position of Army Amateur station WLM-W3CXL located at War Department Signal Center, Munitions Bldg.

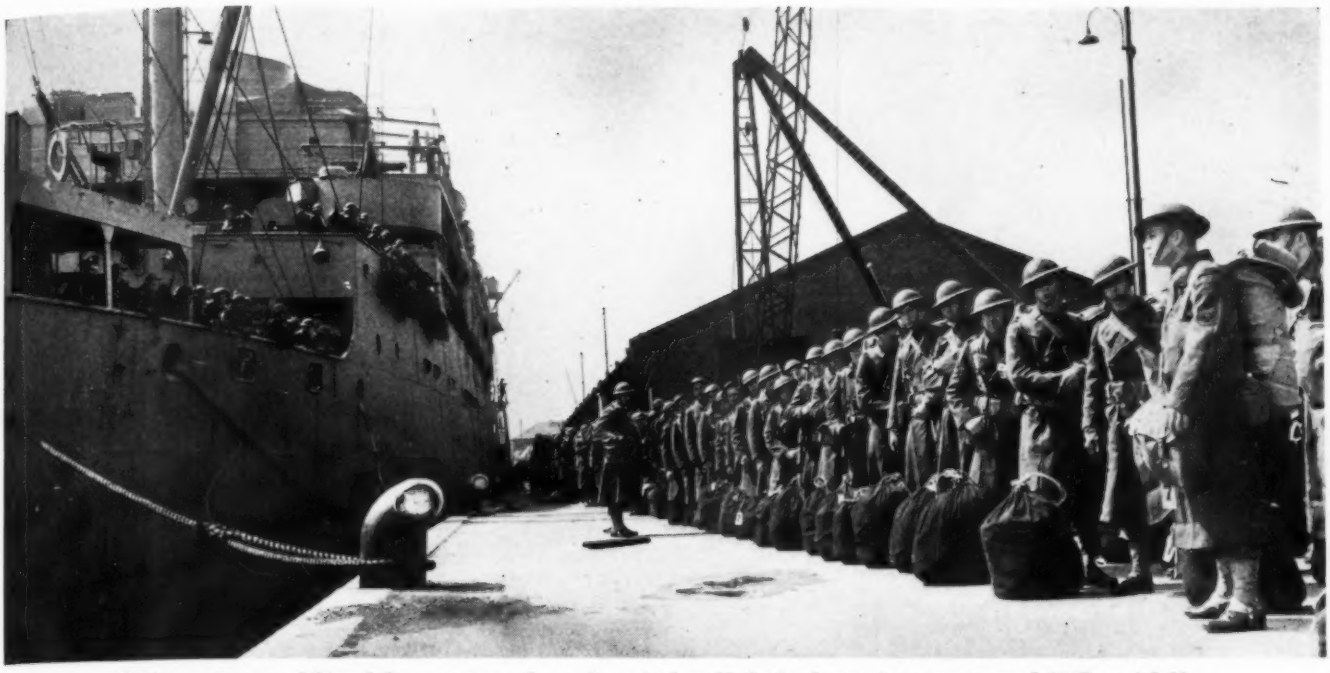
speed in the handling of a constantly increasing volume of traffic, the facilities of the War Department Signal Center and of its "Voice and Ears"—the transmitting and receiving stations of WAR have been steadily enlarged to keep pace. An idea of how the system has had to grow may be had from the fact that the fiscal year 1942 saw gross traffic increased some 70 per cent over the figure for the fiscal year 1941, when more than seventy million words were handled. Equipment in the Signal Center, between the entry of the United States into the war and the end of the fiscal year, increased from six teleprinters to fifty. Numerous rearrangements and improvements were carried out during the year in the facilities of the transmitting station of WAR at Fort Myer, and further betterments will be made as need arises.

The Signal Corps personnel who constitute the staff of the Signal Center and the transmitting and receiving stations of WAR are a group which has no counterpart within the entire army. It is an organization in which every man must of necessity be a highly trained specialist. The average person thinks of a highly trained radio operator as a man who can send radiograms with very little confusion and at a fair rate of speed—say the messages are actually handled at around fifteen or even twenty words a minute for a short period of time. The radio operator in the Signal Service Company on duty at WAR must send or receive or both at a rate of more than fifty words a minute during the eight hours of his tour of duty. He must understand the delicate equipment, such as teletypewriters, radiotypes, and siphon recording equipment. He must be able to read manual signals at more than thirty words a minute, and to handle traffic at this speed if necessary. He must be able to read from recording tape at more than fifty words a minute, and he must be able to operate a teletype machine. It is only through the work of men so skilled as these that the great and growing volume of business of the War Department Signal Center can be handled. Here the Signal Corps' main task—"getting the message through"—is every day being given its most highly refined expression.

Private industry in recent years through the development of machine methods of business tabulation and calculation has provided methods of control of finances, inventories, and status of personnel which government agencies have been quick to adopt. The mechanization of transmission of messages by means of teletype and radiotype—another comparatively recent development—can be combined with the first to bring about great savings in time and effort. Such a system is essentially one of elec-

(*Continued on page* 210)

Section of Signal Corps radio operators and the master control board at Signal Center.



This contingent of Signal Corps troops after safe arrival at N. Ireland port is eager to send "73" to Adolf.

The Signal Corps in Great Britain

by Maj. ROBERT E. HERTZBERG

These highly trained communications specialists are ready for any action which will hasten our final victory.

Born in New York in 1905. Attended the College of the City of New York and Columbia University. Became editor of RADIO NEWS in New York in 1928. Commissioned a 2nd Lieut. in the Signal Corps Reserve in 1928, promoted to 1st Lieut. in 1932, to Captain in 1939, to Major in 1942. Assigned to the Office of the Chief Signal Officer, 1940. After serving as an instructor in the Signal Corps School at Fort Monmouth for some months, attended a special course at the Command and General Staff School, resuming his work at Fort Monmouth in October, 1941. Has been on regular active assignment overseas since June, 1942.

BECAUSE of the strict military censorship in effect wherever American forces are located, it is not possible to describe in detail the splendid work being performed by Signal Corps troops with Signal Corps equipment in the European Theater of Operations. Currently, this "theater" is confined to the British Isles, but public speeches by the Chief of Staff of the Army have made it clear that our sphere of operations will extend to Continental Europe. A grim job must be accomplished there, and the Signal Corps is doing its part toward insuring its eventual success.

Communication troops with fighting organizations are being trained intensively and realistically. They fully understand what is expected of them, and they are applying themselves vigorously and seriously. Notably absent from the scene here is the picnic atmosphere characteristic

(*Continued on page* 208)

Demonstrating the operation of a Signal Corps switchboard to an interested group of spectators in Great Britain.

Bedding down a tank for the night. This one has latest FM transmitter and receiver. Every man is trained in radio.

THE GREATEST OPPORTUNITY OF ALL TIME

by PETER L. SCHAUBLE

The Signal Corps has started on one of the greatest technical educational programs in history to teach radio specialists.

Safeguarding our Stars and Stripes is the duty of men selected to serve as operators in the Army Signal Corps.

Administration Building at Ft. Monmouth. Russel Hall is familiar landmark to thousands of Uncle Sam's radiomen.

Vice President of the Bell Telephone Company of Pennsylvania. A graduate of the University of Pennsylvania, associated with the telephone business since 1913. Has served as advertising supervisor and as general information manager for the telephone concern, and entered present duties in 1941. President of the Poor Richard Club, famous Philadelphia advertising organization. Author of "The First Battalion," the story of the telegraph battalion which was organized from Bell Telephone Company employees in 1917. Served in France throughout World War I. Now Special Assistant to the Chief Signal Officer.

THIS is a tough article to write. Why? Because the Signal Corps needs people—many, many people—and I dare not say how many. Talking in generalities takes the punch out of an article.

I'd like to tell also how many radio sets the Signal Corps will have in operation a year from now. But I can't mention it. Might give some comfort—or more likely some concern to the enemy. And we can't afford to do the former. The latter might be o.k.

So, I must be general. But even at that, here is a story with facts enough in it so that every American should be interested.

When I speak of radio sets, I mean all kinds: the small ones—the not very costly and not very complicated kind—and also the large complex ones which do things which I can't even talk about. But take it from me, our Army has some honeys!

This is a Radio War. Sure, the great majority of the messages go over wires. They have to. There aren't enough wave lengths to handle all the business of a great war, if it were all done by Radio. But this is a War of motion—moving planes, moving tanks, moving armies—and where there is quick movement, there must be instant control and that spells Radio. A tank without a radio is about as helpless as a boat without a rudder. An airplane without a radio is a dead pigeon. And a coast line or an armed force without protection apparatus is like a wide open door for a burglar—or an assassin.

Then too, there is the centralized control and direction of this whole world wide conflict which covers almost every square inch of the Earth's surface. That's a communication job, too—and a whale of a job!

Now the Signal Corps is the Communications of the Army. And Communications mean complex mechanisms. And complex mechanisms mean maintenance. And maintenance means experts. And that's where this article starts.

For the Signal Corps needs people. The fact is that all those radio sets in all those moving vehicles used for fast shifting armies must be kept in tip-top shape at all times. And there are not enough available radio experts in the country today to do the job.

I say "available" experts. Yes, there are a lot of workers in radio and telephone and other communications plants who could do the job. But, if they go into the Signal Corps, who will manufacture all the communications equipment which the Signal Corps demands? More than

These men are receiving a valuable education which fits them for peacetime jobs in industry after the war is won.

$20,000,000 worth every day? No, we can't take the men from the shops. Most of them must stay there and keep up production. When we look elsewhere we find very few folks with the training to do this job.

What to do?

There is only one answer.

The Signal Corps has started on one of the greatest technical educational programs in history. Schools are being equipped and opened in all parts of the country. Vocational Education for National Defense is the name of the organization which is cooperating in this educational effort. So is the United States Civil Service. Likewise, the United States Employment Service.

What do these schools teach?

They will take a student and start him at the beginning of electricity. They will teach him radio, telephony, and on up through the most complex mechanisms which the Signal Corps must operate or maintain.

Who can enter one of these schools?

Any American citizen over 18 years of age—who can show that he has the ability to learn what the schools teach. He must have aptitude—the more technical and mechanical aptitude he has the faster he will progress. High school education is preferable, and one year in radio service work would reduce the amount of training required.

And the applicant must get there before the school is filled up!

For this is a tremendous opportunity and as the information gets around, there will be large numbers of applicants. Not only does the student get an education in science which will without doubt be the basis for the leading businesses of the World after the War is ended, not only does

(*Continued on page* 224)

A common sight in our many training centers are radiomen on their way to classes. Thousands more are still needed.

Lieut. J. L. Lockard, hero of Pearl Harbor, receives his gold bars from Brig. Gen. Van Deusen at the Signal Corps Post.

SIGNAL CORPS HEROES

The success of many campaigns has been made possible by members of the Signal Corps in many theatres of war and under bitter fire.

A RECORD of imperishable glory has been set by Signal Corps heroes since Civil War days.

One of the most hazardous of all arms of the Army, this little exploited or glamorized unit rates high in heroic prestige and accomplishments. Being for the most part a highly specialized branch of military service it has, by necessity, attracted many conservative individuals who seek only advancement of their profession as a reward for their efforts.

A look at the names in war's Hall of Fame reflects the standards on which this branch of the Army was built. Decorations and citations are numerous in relation to the number of enlisted personnel in the Signal Corps as compared to other branches of the service. Such great men as Myer, Greeley and Squier have won the credit and praises of such famous Army leaders as General John J. Pershing, who, shortly after World War I, cited the Signal Corps as "indispensable."

As proof of the fitness of this adjective, we have only to look upon the feat of an enlisted man whose name will forever be linked with the onslaught that brought about the declaration of war by the United States in the present conflict.

Staff Sergeant Joseph L. Lockard, who manned the aircraft detector which picked up the approach of the Japanese air force 132 miles before it reached Pearl Harbor December 7th, is one of the many who have again brought attention to the heroism of Signal Corps men. As a result of his attention to duty during this fierce attack on Pearl Harbor, he was given the opportunity of additional Signal Corps training and was graduated from the Fort Monmouth, New Jersey, Officer Candidate School and commissioned a lieutenant July 12, one day in advance of the remainder of his class of 855 new Signal Corps officers.

Lieut. Lockard received his gold bars from Brig. Gen. George L. Van Deusen, commandant of Fort Monmouth, in a special ceremony broadcast over the Columbia Broadcasting System.

There is every reason to believe that many more equally brave men will be rewarded for their heroic efforts in service, wearing the crossed flags and torch of the Signal Corps.

PREFERRED *for* PERFORMANCE

IRC

RESISTORS

***"In your opinion, is any particular line of resistors superior to the others?"**

This question was put by an independent research organization to a country-wide list of Engineers and Executives in the electronics field. No brand of resistors whatever was mentioned in the questionnaire. Result: *IRC was voted "superior" by more than twice as many as named any other single brand.*

IRC flies the flag of the Army-Navy Production Award

INTERNATIONAL RESISTANCE COMPANY

401 N. BROAD STREET • PHILADELPHIA

Enlisted Men Learn

(*Continued from page* 73)

course offers broad and intense training in the proper methods of analyzing equipment troubles, proper use of the various testing equipment available for field use, and the actual repair of defective equipment in the laboratory. Faults are placed in the various sets by an instructor, and the student is graded according to the method and time consumed in locating the trouble.

The Operation of Fixed Radio Station Equipment subcourse covers instruction in the operation of fixed nets. The object of this course is to develop skill in handling traffic and to give practice in the operation of permanent station equipment. Messages of the form transmitted over the War Department Net are used for instructional purposes. In addition, students are given practice on Wheatstone automatic transmitter tapes, the transmission of them, and the reading of ink recorded tapes.

The Radio Procedure subcourse is subdivided into a Field Nets section, and a Fixed Nets section. The Field Nets instruction covers the procedure and methods employed by radio operators in sending and receiving field radio messages and includes practical application on table nets. The Fixed Nets section instruction covers the proper procedure and methods employed by radio operators in sending and receiving radio messages in fixed radio nets.

The Touch Typing subcourse gives instruction and practice in the use of the typewriter, using the touch system. The Teletypewriter Procedure subcourse offers instruction in the procedure and methods employed in sending and receiving messages by teletypewriters. The Teletypewriter Traffic Practice subcourse gives practical instruction in the handling of traffic between two or more teletypewriters. The Teaching Methods subcourse is a study of the theory of approved teaching methods. This includes practice teaching by each student.

The Test and Repair of Air Corps Communications Equipment subcourse offers detailed instruction on all phases of installation, adjustment, testing, and repair of aircraft radio equipment. All lessons include laboratory procedures on mock plane installations in which the student is required to clear all cases of trouble by the approved methods.

The object of the wire communication course is to qualify personnel in one of the specialties of Cable Splicer; Central Office Repairman; Installer-Repairman, Local Battery; Installer-Repairman, Common Battery; Line Foreman; Powerman; Repeater and Carrier Equipment Maintenance Man; Switchboard Installer; Wire Chief, Local Battery; Wire Chief, Common Battery; and Teletypewriter Installer-Repairman.

The subcourses applicable, in whole, or in part, to the above specialties include Principles of Electricity, Shop Work, Teaching Methods, Substation Installation, Central Office Installation, Substation Maintenance, Pole Line Construction, Cable Splicing, Technique of Field Wire Systems, Basic Wire Communication, Repair of Field Wire Equipment, Field Telegraph Circuits, Local-Battery Telephone and Switchboard circuits, Common Battery Line and Subset Circuits, Common-Battery Switchboard Circuits, Teletypewriter Maintenance, No. 14 Teletypewriter; Teletypewriter Maintenance, No. 15 Teletypewriter; Teletypewriter Maintenance, No. 19 Teletypewriter; Teletypewriter Maintenance, Teletype Keyboard-Perforator; Transmitter-Distributor and Reperforator; Teletypewriter Maintenance, No. 26 Teletypewriter; Teletypewriter Circuits and Switching, Central Office Maintenance, Cable Testing, Power Equipment Maintenance, Telephone Transmission, Repeater Equipment, Carrier Equipment, and Circuit Maintenance.

The Substation Installation subcourse covers instruction and practice in standard methods of installing common-battery substation equipment, from the cable terminal to and including the subset. The subcourse on Central Office Installation gives instruction and practice in post and field-type common-battery central office installation. The student performs all work required, including installation of necessary cables, main frame, power panel, and test cabinet. Substation Maintenance is a subcourse dealing with the causes, diagnosing, and clearing of trouble in the subscribers line circuits and equipment, from the main frame to the subset, inclusive.

The Pole Line Construction subcourse includes instruction and practice in the placing of both open wire and cable plant systems with their necessary supporting structures. The Cable Splicing subcourse covers instruction and practice in testing, splicing, and wiping joints, and the performance of a cable splicer's duties under working conditions. Technique of Field Wire Systems subcourse offers instruction and practice in the installation, operation, and maintenance of the field wire systems used in a division or smaller unit. The Basic Wire Communication subcourse includes instruction in the installation and maintenance of local-battery field wire lines and telephones.

The Field Telegraph Circuits subcourse covers the principles of open and closed circuit telegraphy and a detailed study of the telegraph equipment now in use with field organizations. The Local-Battery Telephone and Switchboard Circuits subcourse offers a comprehensive study of the fundamental theory of basic local-battery telephone lines, switchboard, and testing apparatus, and of the particular equipment used in local-battery field systems. The Common-Battery Line and Subset Circuits subcourse covers the fundamental theory of operation of common-battery substation and central office line circuits. The subcourse on Common-Battery Switchboard Circuits covers instruction in the theory of operation of circuits and apparatus of common-battery manual switchboards, and associated equipment, with special emphasis on the types employed by the Army on post and field telephone systems.

The subcourse on Teletypewriter maintenance is divided into six sections covering the five types of machines and a section on Circuits and Switching. Each section of the subcourse relative to machine types covers a study of functioning, disassembly and reassembly, trouble analysis, and maintenance. Each student is required to clear from twenty-five to fifty cases of trouble on each type machine. Circuits and Switching is concerned with the installation of the teletypewriter, including station and switchboard equipment, together with appropriate lineup procedures and tests. The Central Office Maintenance subcourse includes instruction and practice in the maintenance and operation of common-battery telephone exchanges including main frames, power equipment, testing equipment, and records, also in locating and clearing troubles in central office apparatus and in routine maintenance practices.

The subcourse on Cable Testing covers instruction and practice in the use of equipment for determining the nature and location of trouble in cables. Power Equipment Maintenance is a subcourse of instruction in the installation, operation, and maintenance of telephone power equipment used for both permanent and field-type central offices, and the care and operation of various gasoline engines used to drive portable generators.

The subcourse on Repeater and Carrier Equipment Maintenance is divided into four sections. *Telephone Transmission* includes a study of the fundamentals of telephone transmission, vacuum tube principles, and testing equipment as applied to comparatively long telephone lines. *Repeater Equipment* covers instruction of vacuum tubes, testing equipment, telegraph composite sets and composite ringers. *Carrier Equipment* covers the principles of operation of carrier telephone equipment at circuit terminals and intermediate locations. H-1 carrier equipment is used as a basis. *Circuit Maintenance* covers instruction on methods of circuit lineup and maintenance of circuits equipped with ringers, repeaters, and carrier equipment.

Camp Charles Wood, also a sub-post of Fort Monmouth, located near Eatontown, New Jersey, contains the Signal Corps Replacement Training Center. The Signal Corps also has a Signal Corps Replacement Training Center and an Enlisted Men's Department at the Midwestern Signal Corps School, Camp Crowder, Missouri.

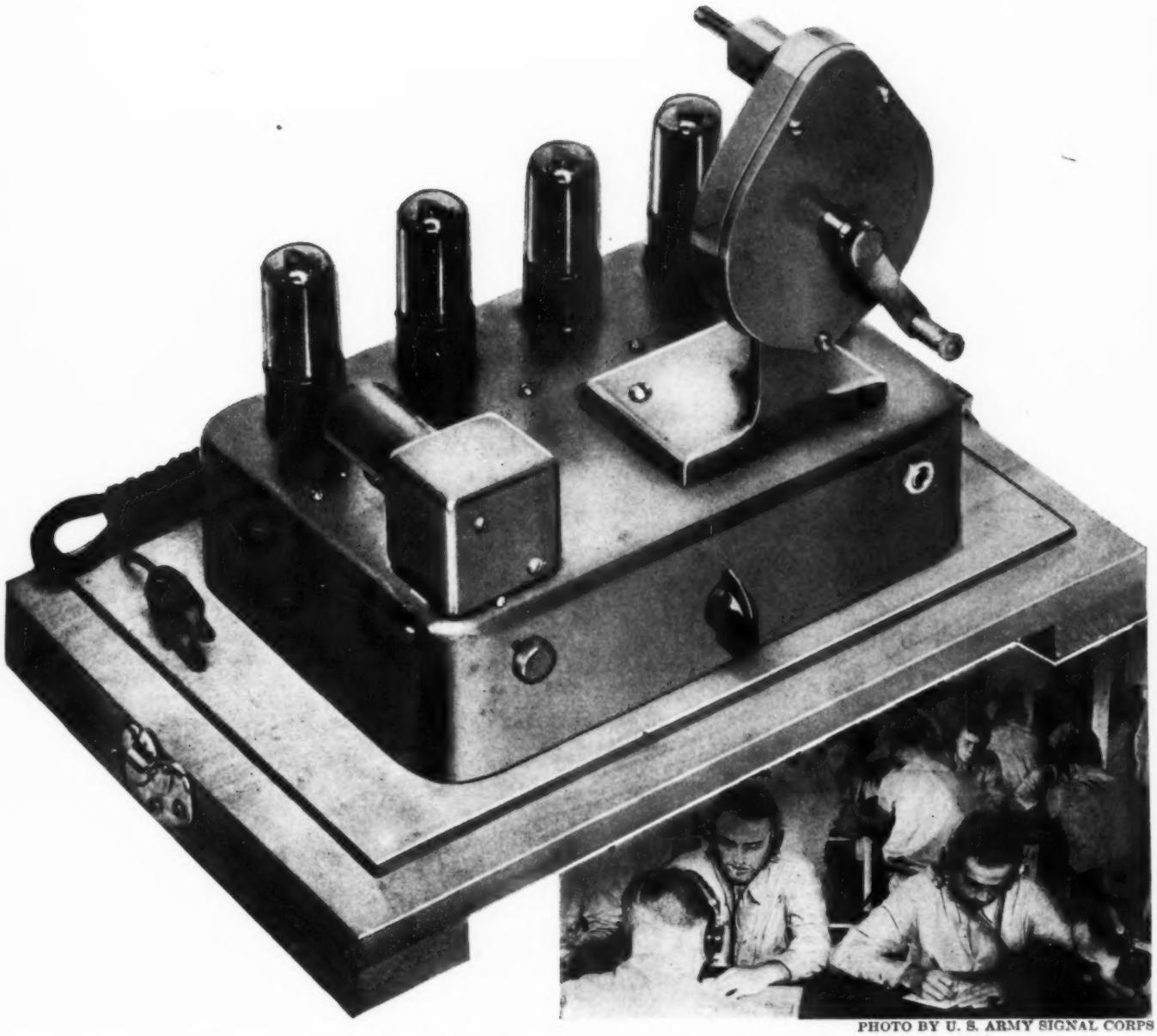


PHOTO BY U. S. ARMY SIGNAL CORPS

AS MANY AS 300...

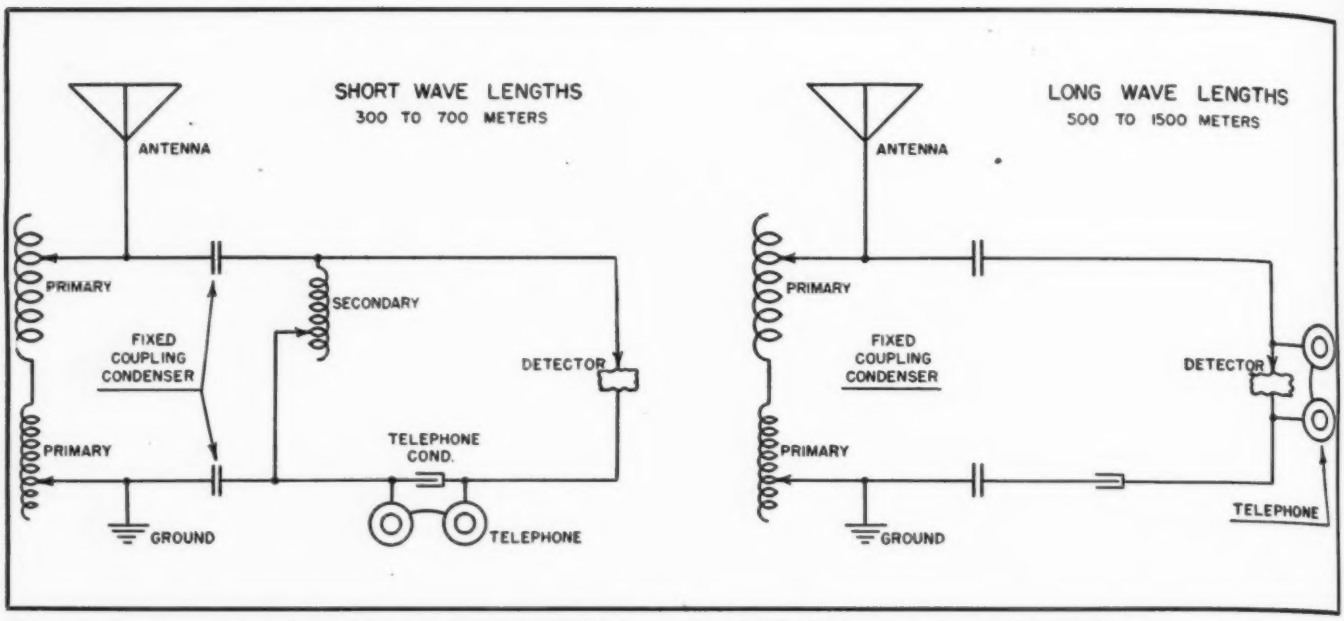
This McELROY model G813-742, designed by the world's champion telegraphist for individual or group instruction, incorporates an electron keyed, built-in tone source with an output of sufficient strength to energize three hundred sets. The unit is planned to teach wireless telegraphy with a minimum of time, effort and expense.

We provide tapes with a heavy writing line in black ink. The phone jack on the right is for monitoring; the center pointer for sensitivity control of the photo cell; and the knurled knob at the left for adjustment of the inked tape gateway between the exciter lamp and the photo tube. Four 117N7GT or 117P7GT tubes, T7 exciter lamp and 930 photo tube.

The slip, mounted on 16mm., 400 ft. motion picture reels, is drawn between the exciter lamp and the photo tube, the tape puller rewinding the slip onto a take-up reel. At a character speed of 20 words per minute, each roll of slip will last approximately one hour, travelling at the rate of 12 feet per minute. Master rolls of a 15 roll set of practice tapes, G15AA, have been furnished to us by the U. S. Army Signal School at Fort Monmouth, N. J.

McELROY MANUFACTURING CORPORATION

82 BROOKLINE AVENUE **BOSTON, MASSACHUSETTS**



Even though few parts were required, this set was quite bulky in comparison to later models.

1915-Type C Receiving Set

Older Signal Corps members will remember this set used prior to World War I. Crystal detectors were in vogue and variable condensers were to follow.

IN the earlier sets, types A and B, the two circuits were magnetically coupled, that is, the current in the primary (closed detector) circuit by means of magnetic lines which passed from the primary coil through the turns of the secondary coil. In the present set the two circuits are statically coupled; that is, the current in the primary circuit induces current in the secondary circuit by means of static lines in two coupling condensers connected in the leads between the circuits. The transfer of the energy from the primary to the secondary circuit for the operation of the detector and telephones is as efficient in this type of connection as in the other. By choice of suitable values of the coupling condensers no movement of the coils or changes in coupling is necessary for the reception of any wave lengths within the range of the set, as is the case in the former sets. This reduces the number of adjustments for tuning from 4 to 3, and at the same time the set is much more rugged, as there are no moving parts. The values of the coupling condenser have also been so chosen as to make the set much more selective than the others; that is, it can receive signals from a station on one wave length and cut out signals from another station on a different wave length more completely than before. In addition to the above advantages, the set as a whole has been found to be more efficient than the previous types.

The type C receiving set consists of two statically coupled circuits, high-resistance telephones, stopping condenser, fine wire-galena detector, switch for short and long wave lengths, three dial switches for tuning, etc.

The primary circuit consists of: (1) The antenna, which when the control switch in the cover of the chest is thrown to the "Receive" position, is connected by a double plug with flexible wires to the binding post on the set marked "A"; (2) two primary coils in series, one large and the other small, the number of turns in both of which is variable by means of two dial switches marked "Primary." On each coil there are contacts, 0 to 24, for tuning to different wave lengths, the dial nearest to the binding post "A" being connected to the large primary for large changes in wave length and the other to the small one for small changes and fine tuning; (3) counterpoise which is connected to the binding post marked "C" through the double plug and control switch. There is no series condenser in the antenna circuit for the reception of wave lengths shorter than the fundamental wave length of the antenna, as in types A and B, as it has been found to be not generally useful.

When comparatively short wave lengths are to be received, as from 300 to 700 meters, the double-pole double-throw switch on top of the set should be thrown to the position marked "Short." This makes no changes in the primary circuit, but connects into circuit (1) the secondary coil with the dial switch marked "Secondary," with contacts 0 to 24 for tuning to different wave lengths; (2) detector and telephones.

Short wave signals should be picked up by adjustments of the large primary and the secondary dials, and fine adjustments made later on the small primary dial.

When longer wave lengths are to be received, as from 500 to 2,400 meters, the D-P D-T switch should be thrown to the "Long" position. This makes no changes in the primary circuit, but disconnects the secondary coil, which in this set is most useful only at short wave lengths, and connects the circuits as shown in the second print. As the secondary coil is not in circuit, only the two primary dials are effective in tuning.

Long wave signals should be picked up only by adjustment of the large primary dial and fine adjustments made later only on the small primary dial.

Receiving Set, Type D

This set is practically the duplicate of the type C, except that the number of studs in the three dials has been increased so as to give finer tuning.

• • • — • —

PHOTO BY U. S. ARMY SIGNAL CORPS

A VISUAL TRAINING AID!

Telegraphy can be taught more quickly with McELROY Recorder, Model RRD-900-742. The sight record of student transmissions enables the instructor to demonstrate and correct errors easily. This rugged unit, designed primarily for school use, will record signals at speeds no greater than 100 words per minute. If greater speed and sensitivity are required, use McELROY Model SR900.

A key or keying device is connected directly to the two terminals at the right. No batteries are required. A heavy line stylus inks the dots and dashes upon the paper slip as it is drawn by the Tape Puller. A distance of 25-30 feet is required to dry the heavy black ink. The left terminals are to record signals directly from a radio receiver.

Besides the invaluable teaching use, the Recorder is designed to produce inked tapes to key any Graphic Keying Unit, such as McELROY G813-742 or the Army TG-10, which is an adaptation of the McELROY Photo Tube Keyer.

McELROY MANUFACTURING CORPORATION
82 BROOKLINE AVENUE BOSTON, MASSACHUSETTS

1913—Field Radio Pack Set

From out of the past comes this portable spark set. It took quite a crew for its operation. Pancake inductance was used to conserve space.

RADIO pack set, Model 1913, consists of the following units: operating chest, hand generator, mast, pack frames, tent.

Each unit contains component parts as follows:

Operating chest: chest; resonance transformer; condenser; oscillation transformer; sending key; spark gap; hot-wire ammeter; switch; receiving set; connecting cord for generator (4-conductor, with plugs); connecting cord with plug for antenna; double-head receiver; test buzzer; tool kit; extra section for transformer secondary; extra set crystals; canvas case for receiver; connector, 4-wire (lower half), generator; connectors, 2-wire (lower half), antenna and counterpoise; copy "Radiotelegraphy."

Hand generator: generator, cranks, stand, speedometer (carried in operating chest), cap for speedometer opening, canvas hood.

Mast, type F (Type D mast has top, bottom, intermediate and extra sections): top section; bottom section; intermediate sections, extra (for tent); antenna, counterpoise; carriers, wire; pins, antenna; hammers; set adapters for tent; bag, antenna and counterpoise; bag, accessories.

Pack frame, set: frames (1 set). Each frame is complete with cincha, 3 cincha straps with rings and snap hooks and 2 straps with snap hooks at each end.

Tent: tent, pins, guy ropes, insulating device.

Antenna and Counterpoise

The standard antenna is of the umbrella type with four radiating wires, each 85 feet long, suitably insulated at the open ends and held as nearly horizontal as possible by guy rope extensions, each 85 feet long, the outer ends of which are made fast to ground pins. The standard counterpoise has four radiating insulated wires, each 100 feet long, laid out on the ground under the antenna wires. Both antenna and counterpoise wires are carried on hand reels for convenience in packing and quick reeling and unreeling in setting up and taking down the mast.

Generator

The generator is a hand-driven, 18-pole, alternating-current machine having an intermittent output of 250 watts at 110 volts and 500 cycles at a speed of 3333 r.p.m. It is self-excited, the exciting current for the fields being generated by a small shunt-wound direct-current machine, the armature of which is mounted on the same shaft as the alternator armature. The exciter has two poles and delivers the direct current at about 110 to 150 volts. The whole machine is driven by two handles, which should be turned at the rate of 33 r.p.m. to give the necessary armature speed of 3333 r.p.m., the combination gear having a ratio of about 100 to 1.

Speed Indicator

A speed indicator is mounted on the upper part of the gear case in sight of the men driving the machine so as to show if it is being driven at the proper speed, at which time the red line on the moving vane coincides with the black index or arrow at the window. The vane is divided diagonally into black and white parts, the white showing if the speed is too low and the black if too high.

Gearing

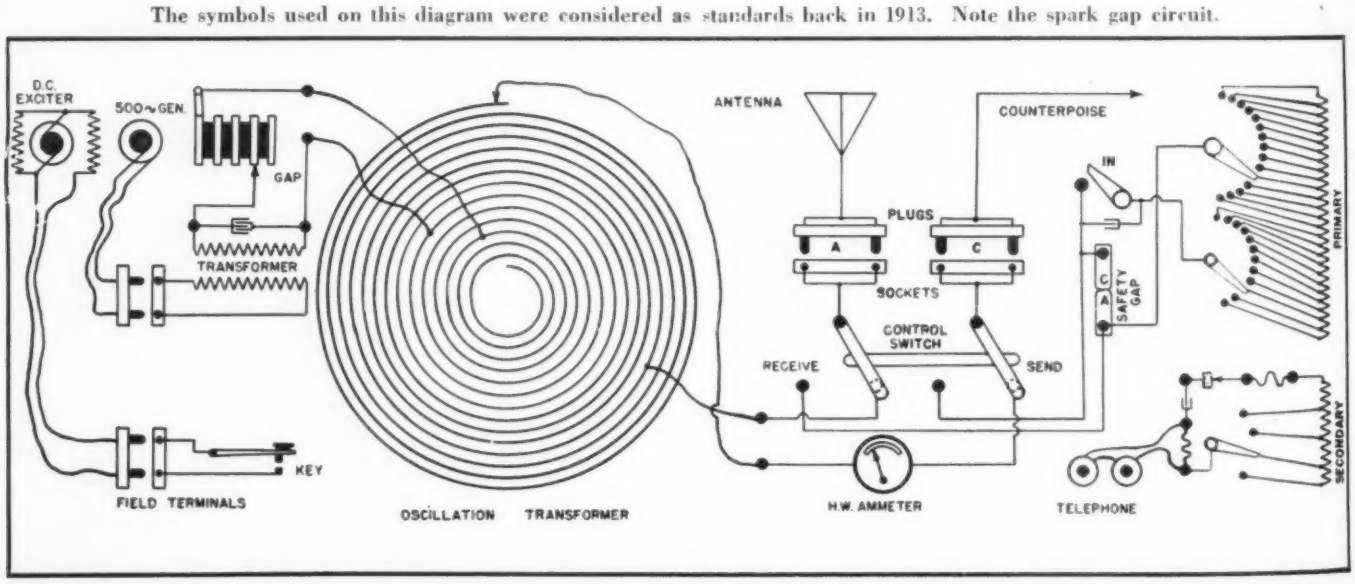
The gearing is a combination planetary worm-and-spur type of high efficiency when in proper alignment. The high-speed shafts have ball bearings and the gears run in grease or oil so as to reduce the friction as much as possible. The gears should never be taken apart unless absolutely necessary to replace worn or broken parts, and then only by an experienced person. If not properly reassembled, or if the driving gear does not run perfectly true with the worm, undue friction and wear will result, the machine will be harder to turn than before, and the gears will be speedily destroyed.

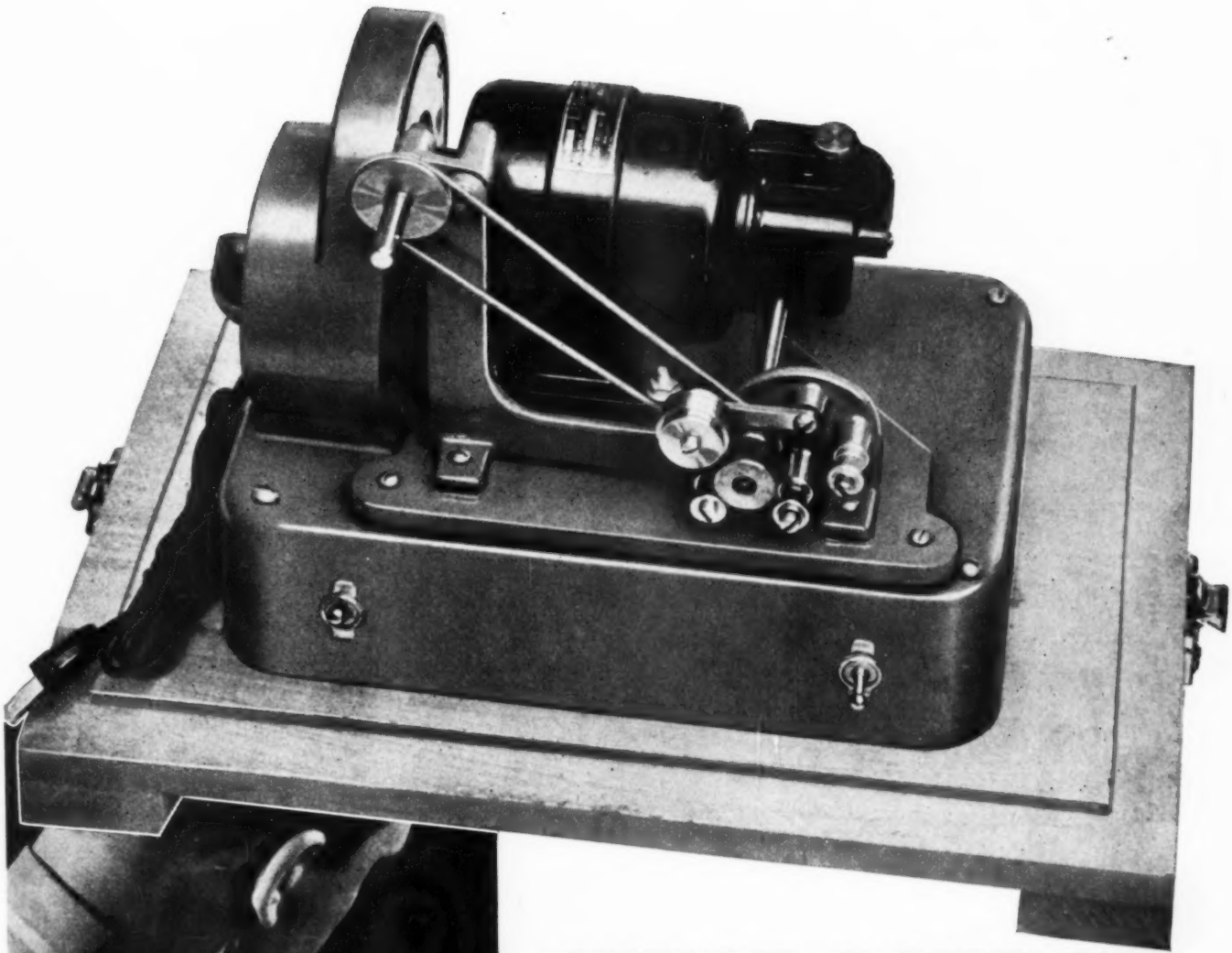
Connections

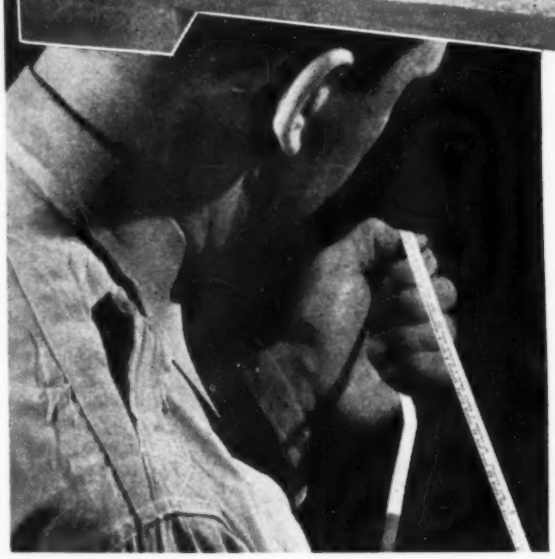
The leads from the armature of the a.c. generator are directly connected to the transformer primary by means of the heavy pair of wires, the larger plug of which being put into the socket at the left-hand end of the operating chest marked "Gen." and the smaller plug into the socket on the underside of the gear case, also marked "Gen." The sending key is in the circuit of the alternator fields and the exciter armature, and is so connected by means

(*Continued on page* 142)

The symbols used on this diagram were considered as standards back in 1913. Note the spark gap circuit.







WE'VE DONE IT...

We always wanted to make a really professional tape puller . . . and now we've done it. Model TP-890-742 is thoroughly suitable for all commercial and school applications. It is the result of a constant improvement in design and production methods.

Examine Model TP-890-742 carefully. Observe the die-cast housing which protects the sturdy AC/DC motor . . . the oversize brushes and commutator . . . the die-cast, dynamically balanced flywheel. Only oilite bearings are used. Another innovation is the hub holding the take-up reel. The arm-like arrangement can free the wheel if the slip requires rewinding or if the operator wishes to maintain constant speed and, at the same time, save the paper slip when not actually recording.

The left switch turns the tape puller on; the right one controls speed: up for "high," down for "low." Engineered for simple operation. Pass the paper slip over the top of the right roller, down under the middle one, up over the rubber covered motor shaft and then between it and the idler roller, down under the left roller and into a basket or onto the take-up reel.

McELROY MANUFACTURING CORPORATION
82 BROOKLINE AVENUE BOSTON, MASSACHUSETTS

CRONAME★
tooled for Victory
for the duration

AN EXPERIENCED ORGANIZATION OPERATING THREE PLANTS 100% ON WAR WORK. PRODUCING AIRCRAFT AND OTHER IMPORTANT PARTS.

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ANODIZING . . . . . ASSEMBLING
WELDING . . . . . PLATING
ETCHING . . . . . ENAMELING
LITHOGRAPHING . . . . STAMPING
PRESS WORK . . . EMBOSSING
ALUMINUM HEAT TREATING
FLUORESCENT PROCESSING

A SELF CONTAINED PLANT WITH COMPREHENSIVE EQUIPMENT TO SERVE YOU NOW AND AFTER THE DURATION

CROWE NAME PLATE & MFG. CO.
1752 WAVELAND AVENUE
CHICAGO ILLINOIS

INVEST IN WAR BONDS

1913 Pack Set

(*Continued from page* 140)

of the light pair of wires the larger plug of which being put into the socket at the left end of the chest marked "Fld." and the smaller plug into the socket on the underside of the case, also marked "Fld." By the use of these circuits, the electrical load on the machine is limited to the small one of the exciter field, except when the key is closed in sending. Experiments have shown that twice the output of the former machines can thus be obtained with no more tiring effects on the men than before.

Operating Chest

In this chest is mounted the transmitting and receiving apparatus. To put the chest in condition for sending, connect the double contact plugs of the leads from the hand generator, field, antenna, and counterpoise to the receptacles marked "Gen.", "Fld.", "A" and "C" respectively, and the four variable contact clips on the leads from the condenser, spark gap, antenna, and hot-wire ammeter, to the four points on the flat spiral, as indicated on the diagram, making sure that the counterpoise clip is at the end of the outside turn. Set the control switch at the "sending" or lower position. Release the indicating needle of the ammeter by turning the small knurled screw at the left-hand side of the upper binding post. When the needle is free, adjust to zero position on the scale by means of the small knurled screw at the right side of the upper binding post. Set the variable spark-gap contact on the fifth plate, counted from the left end, so as to put four gaps in circuit. Start the generator, and when the proper speed is obtained the set is ready for sending.

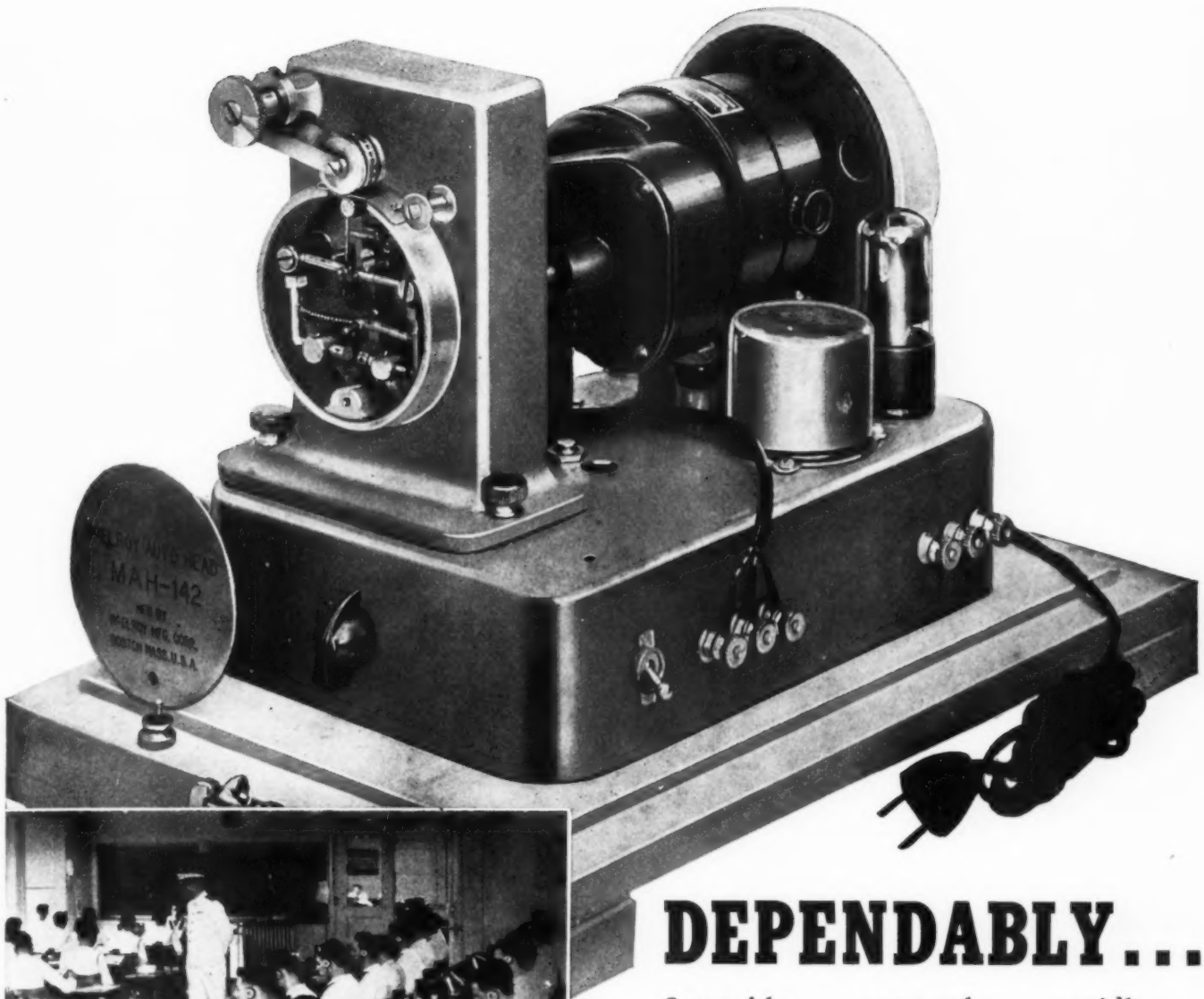
Quenched-Spark Gap

The spark gap used in this set is made up of several copper disks separated by mica washers about 0.01 inch thick. Its action is to allow all of the energy of the closed oscillating circuit to be transferred to the open or radiating circuit in a few oscillations, after which the spark is quenched and the circuit is, in effect, open. The activity in the closed circuit having ceased, the open or radiating circuit continues to oscillate at its own period, radiating waves of its own wave length without any retransfer of energy to the closed oscillating circuit, which continues to remain open until a spark breaks down the gap again at the peak of the next alternation.

Tuning of Sending Set

The tuning of the closed and open circuits to resonance, and the determination of the correct coupling between them are the two most important adjustments in a quenched spark transmitter. In the present type of directly coupled set with a flat spiral as the oscillation transformer, these adjustments can be made either with or without the help of a wave meter. If made without the meter the adjustments are more difficult and must be found by trial, but they should satisfy the following tests: (1) The number of turns in the closed circuit should be chosen so as to give the desired wave length; (2) the antenna hot-wire ammeter should show the maximum reading that can be obtained by adjusting the number of turns in the open circuit according to the table given later; and (3) the note as heard in the telephones of the receiving set should be clear and characteristic of 500 cycles. These adjustments are, in general, dependent on each other, an incorrect change in one seriously affecting all the others; but when obtained the circuits will be in resonance at the desired wave length, they will be correctly coupled and the closed-circuit condenser will be charged and discharged regularly once per alternation.

Although a transmitting set using the flat spiral oscillation transformer is not as easily tuned as some other types, yet when the adjustments have once been made and tabulated it is practically as efficient as other types. It has the advantage of being one of the simplest, most rugged and compact forms which can be installed in a field set. . . . — . —



RADIO NEWS PHOTO

DEPENDABLY...

Smoothly . . . accurately . . . rapidly . . . McELROY is producing precision-built, urgently needed telegraph apparatus.

Designed by the world's champion telegraphist and outstanding wireless operator of all time, our equipment is rendering unfaltering service under all the intense wartime traffic . . . including the task of training thousands of new wireless operators in the shortest possible time.

Illustration: Model XTR-442 Tape Transmitter, operates accurately at controlled speeds ranging from 5 to 250 words per minute.

McELROY MANUFACTURING CORPORATION

82 BROOKLINE AVENUE **BOSTON, MASSACHUSETTS**

S. C. Training
(*Continued from page* 64)

Corps. They are allowed to complete their college course before being called for military service and then are eligible for appointment as second lieutenants.

The Department of Training Literature of the Eastern Signal Corps School prepares War Department field manuals and technical publications pertaining to signal communication for all arms, Signal Corps doctrine, and Signal Corps equipment. Other duties include the preparation and revision of the extension courses of the Signal Corps School and preparation of material for and supervision of non-photographic phases of production of training films about the Signal Corps and signal communication for all arms subjects.

To represent their respective branches in a liaison capacity, an infantry officer, a cavalry officer, a field artillery officer, an Armored Force officer, and a Marine Corps officer are assigned to the school by the War Department. These officers also assist the Officers' Department by instructing in such phases of signal communication tactics and technique as pertain to their own arm.

These liaison officers have been selected for their ability to detect the natural inherent tendencies of students to quickly adapt themselves to the various phases of communications that pertain specifically to the individual arms. For example, a student might logically have been a metropolitan police officer in civilian life—particularly skilled in the art of transmitting and receiving radio telephone messages while on duty in fast moving police cars. This student would be qualified for duties as a vehicular radio operator.

Another might have come from a rural district—possibly employed as a truck mechanic, farm tractor operator, or machinist, with a flair for radio—excellent timber for a communications assignment in the Armored Force. All students recognize the necessity for streamlining their efforts to harmonize with the equipment they use.

The complexity and the lightning-like speed of modern warfare demands dependable communications under all circumstances and conditions. Fort Monmouth, with its Eastern Signal Corps School and its Replacement Training Center, is one of the group of organizations which provide a highly integrated, closely controlled educational system for the Signal Corps.

Taylor Tubes
HAND IT OUT—
IN NATIONAL DEFENSE TRAINING!
Defense Training Class, Seneca Vocational School Buffalo, N.Y. Dr. Elmer S. Pierce, Principal. Earnest H. Roy, Instructor in Radio Communication (W8RV)
Taylor Tubes Now Licensed by RCA
TAYLOR TUBES Can Take It Too!
This unusual photo shows how Taylor Tubes hand out RF on the ultra high frequencies. Experimental transmitter operating on 3 meters uses a pair of TW-150 tubes running at 1200 watts input to a long-lines oscillator. Output of this unit was so high that touching the plate rod with a pencil would create an arc about 4" long. The arc would continue to stand up in the air after the electrode was taken away and until the power was cut off.
"MORE WATTS PER DOLLAR"
Taylor HEAVY CUSTOM BUILT DUTY Tubes
TAYLOR TUBES, INC., 2341 WABANSIA AVE., CHICAGO, ILLINOIS

IN ACTIVE SERVICE . . .

McELROY PROFESSIONAL COMMUNICATIONS EQUIPMENT

Signals at speeds from the lowest up to several hundreds of words per minute are fed from a good communications receiver, such as the Hallicrafter, into the signal leveller, SL990. Nearly all noises are eliminated and a clear strong signal is fed into the ink recorder SR900. Paper slip is drawn across a typewriter by Tape Puller TP890, the operator transcribing by sight reading onto the mill. One of McElroy's high speed recorders has been in use on a commercial communications circuit producing beautiful inked characters at 300 words per minute.

Note the McElroy chart on the wall in the photograph. Into the making of this chart has gone the 25 years of experience of the outstanding wireless operator of all time. Using this chart makes it possible for an operator to learn to read inked slip within one month at speeds exceeding 50 words per minute. We'll be glad to mail you a chart upon request. There'll be no charge and the chart contains no advertising matter.

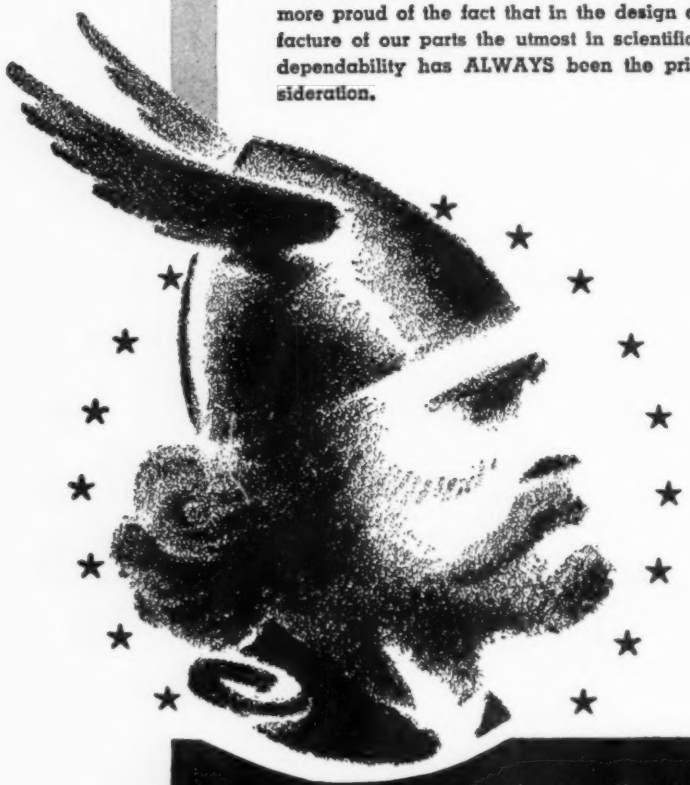
McELROY MANUFACTURING CORPORATION
82 BROOKLINE AVENUE BOSTON, MASSACHUSETTS

THE VIKING FAMILY FIGHTS FOR FREEDOM

★ ★ ★ ★ ★

Famed ***Viking*** products are on the war fronts of the world! We of the E. F. JOHNSON COMPANY take great pride in the knowledge that everywhere dependable JOHNSON components are a part of the mailed might that surges at the enemies throat. Day and night, through fair weather and storm the ***Viking Head*** trade mark is with our fighting men . . . with begoggled fighter and bomber pilots in lead filled skies . . . with the field artillery . . . the infantry . . . in the tanks and armored cars . . . on the battleships, carriers, cruisers, destroyers, and other vessels of our navy. JOHNSON products play a vital part in the protection of our civilian lives as well.

We could ask no greater reward for our efforts than the immense trust that is daily being placed in our products. The reliability of the equipment of war placed in the hands of our fighting men will be measured in life and death itself. Never will we be more proud of the fact that in the design and manufacture of our parts the utmost in scientific skill and dependability has ALWAYS been the primary consideration.



JOHNSON

a famous name in Radio

Midwestern
(*Continued from page* 69)

ratus in operation in knotty situations, he is ready to go to a combat unit.

Another essential division of Midwestern is its wire communication school. Training in this school qualifies soldiers for all types of installation, repair and maintenance work used in telephone and telegraph communication. Courses taught in the wire school are wire chief, local battery; wire chief, common battery; switchboard installer; installer repairman, common battery; switchboard installer; installer-repairman, local battery; repeaterman; cable-splicer; frameman; powerman; inside man and telegraph printer maintenance man.

In the wire school as in the radio division, attention is given the individual for the mutual advantage of the Army, as well as the soldier. For example, one soldier with years of experience as a powerman was found to be adept with his hands. It was suggested to him that he become a telegraph printer maintenance man, because the Army did not need powermen at the time but needed many telegraph printer repairmen. He knew that he could earn more on such a job after the war than on the one he had had before. So he jumped at the chance. Wire school students, like radio men, are assigned to combat units whenever they complete their course.

Civil service instructors are taking an increasingly important part in the activities of this all-Signal Corps-Army project.

Patriotic men who, because of some physical defect or family obligation have been unable to don a uniform, have found a place where they can serve Uncle Sam. By teaching at Midwestern, they can release able-bodied officers and enlisted men, now acting as instructors, for active combat duty where they are vitally needed.

The commandant of Midwestern Signal Corps School is receiving applications daily for instructor positions in every branch of radio and telephone work taught in the school.

Those who have specialized in any branch of this work and are found qualified to teach it are employed, if not subject to immediate induction in the Army. A large number will be required to fill vacancies now open.

Hams, in particular, are finding their place in this extensive program. They make excellent instructors on various radio subjects. If you have held a ticket—Uncle Sam can use you. Write—stating full qualifications to the commandant at Camp Crowder.

...—.—

"Where Skill and Courage Count"
U. S. Army Signal Corps

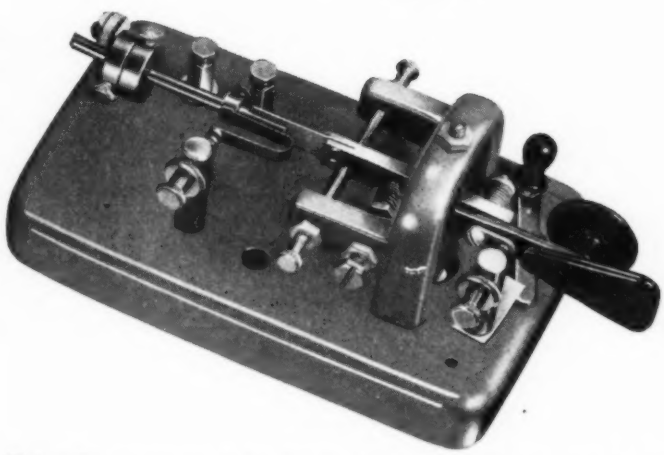
A FEW AIDS TO GOOD SENDING

MASTER OSCILLATONE MS-700

This powerful audio oscillator may prove to be most valuable in teaching or learning code. Operates on 110 volts, either AC or DC. Uses 117N7GT or 117P7GT tube. Headphone output is "off the ground" with additional provision for keying "off the ground." Whenever desired, speaker can be cut out entirely. Encased in attractive plastic case with protective speaker grille.

MODEL 200 STREAMKEY

McElroy, the world's champion telegrapher, continues to set the pace in the design and construction of keys that are ideal aids to sending good code. This manual streamkey is well proportioned with the heavy metal base casting finished with two coats of baked wrinkle enamel. Balanced key lever with pigtail connection to base. 3/16" platinoid contacts. A "natural" for any operator.



MODEL 500-742 SPEED KEY

An excellent, professional "speed key" incorporating all the design refinements developed by McElroy in his 25 years as a champion American Morse and wireless operator. Metal parts are either cadmium or chrome plated. Pigtail connections, bakelite paddle and knob, 3/16" platinoid contacts, Swedish blued steel main spring and U spring.

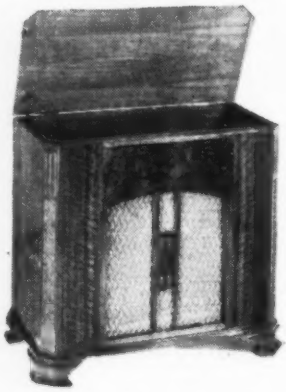
Schools engaged in training operators, and distributors, in the middle or far west may facilitate deliveries of these products by contacting McElroy & Goode, Inc., 325 West Huron Street, Chicago, Illinois.

McELROY MANUFACTURING CORPORATION

82 BROOKLINE AVENUE **BOSTON, MASSACHUSETTS**

SAVE MONEY ON—

CABINETS, RECORDERS, CHANGERS, and RADIO PARTS



OXFORD TYPE PD. A beautiful hand-rubbed, piano-finished cabinet. Made of five-eighths stock. Rose Mahogany and Walnut. A real piece of furniture 33" high, 32" long, 17" deep. Phono compartment 31 x 15 x 6"..... **$26.95**

"LAKE SPECIAL" CHANGER-RECORDER

Magnetic cutting head, crystal pickup, 1¾ ounce needle pressure. 14" wide, 14" long 5" high above board. 3" depth below board 78 RPM. Records on discs up to 10" in diameter. Plays all records. Self-starting dynamically balanced induction motor. Enables you to build a combination recorder and record-changer in a single unit. This month, only..... **$24.95**

Deluxe Changer

Ideal for small cabinets. Only 12" x 13" x 4½" high. Plays 10 12" or 12 10" records. Crystal pickup, offset record suspension, reject switch, smooth action..... **$12.95**

Victory Special . . . — . . . — V

NATIONALLY-KNOWN, HEAVY DUTY MOTOR. Silent, dependable, induction type, self-starting motor; 9" turntable. 78 RPM. Enclosed gears. For 110 v. 60 c. $11.50 List. Now only..... **$4.65**

New Bargain Bulletin Arouses Nation! Gigantic money saving values help Servicemen, Jobbers, Radio Dealers and Sound Men . . . Everyone can save money and help "Keep 'Em Listening" . . . Everybody can improve their business this easy, money saving way. A new cabinet or a new combination radio and phonograph will help make any home a better place to live in. We also save you money on all radio parts. SEND NOW FOR NEW FREE BULLETIN.

LAKE RADIO SALES CO.

615 W. Randolph St. Chicago

First Signal Corps

(*Continued from page* 33)

were an important part of the Signal Corps' work in Cuba in 1898. In the first few years of the century, more work was done with balloons, both dirigible and captive, as well as with the testing of chemical processes needed for the generation of the hydrogen gas used as a lifting agent.

From balloons to heavier-than-air machines was thus but a short jump for the aeronauts of the Signal Corps. In 1907, specifications were prepared and bids invited for a heavier-than-air machine to make forty miles an hour, stay in the air one hour, and be under control at all times. Contracts were awarded to the Wright brothers and to A. M. Herring. Tests with the Wright plane went on during 1908-9, and during these years the Chief Signal Officers, General Allen and his successor General Scriven, stressed in their reports the urgent desirability that the United States foster aviation as part of its military might. The first army aviation school was opened at College Park, Maryland, in 1911, moving to Augusta, Georgia, during the winter. Five airplanes were available that year, and six officers qualified as pilots.

This was a small beginning, but out of it have grown the vast air fleets and the great training program of 1942. The early steps toward that growth were made by the Signal Corps; an automatic machine gun was fired from an airplane in 1912, and in that year aerial photographs were taken. Aerial observation of artillery fire was conducted, using radio communication to ground. Bomb dropping was first tried in 1913. Thus a majority of the present day military uses of the airplane had been tested out by the Corps before 1914, when Congress authorized the establishment of an Aviation Section of the Signal Corps, to consist of 60 officers and 260 enlisted men. Reorganized and enlarged by the National Defense Act of 1916, this Aviation Section of the Corps was ultimately to become the Army Air Force.

The Signal Corps was ready to use radio-to-ground communication in observing artillery fire from the air in 1912-13 because it had for a long time been actively working on the problem of adapting radio to military use. This undertaking had been begun in the nineties, and as long ago as 1899 signal officers had put into operation over the 12-mile stretch between Fire Island and Fire Island Lightship the first radio communication regularly and publicly operated in America.

Signal Corps enlisted operators in the next year installed and successfully operated a radio system in San Francisco harbor. The DeForest Fessenden, and Marconi systems all were tested by the Signal Corps in 1902, and in the year following, the Fessenden system was set up in Alaska. This installation, consisting of stations at Safety Harbor and Saint Michael, provided communication across the 107 miles of Norton Sound. It had antenna masts 210 feet high, and employed a three kilowatt spark set with a DeForest receiver.

This work of getting radio tied into the general communications network of the Corps was pushed vigorously, so that by 1908, the Signal Corps had in operation six station sets in the United States, eight in Alaska, one in Cuba, two in the Philippines, and five on army transports. These sets ranged in power from three quarters of a kilowatt to ten kilowatts. Experimental work in radio telephony was begun in 1907, paving the way toward the first successful test of an airplane radiotelephone set, made at Langley Field, Va., ten years later. In 1916, at the end of the interim period we are talking about, the Signal Corps had 105 permanent radio stations in operation.

Such are some of the principal highlights of the Signal Corps and its work between 1899 and 1916. In these years, the strength of the Corps was increased from less than a thousand officers and men in 1900 to a peacetime strength of 127 officers and 4,000 enlisted men under the terms of the National Defense Act of 1916. As would be expected, methods of training had to be expanded during this period of such scientific and engineering activity.

The Army Signal School was instituted to this end at Fort Leavenworth in 1905 for the purpose of preparing Signal Corps officers for the better performance of their duty, of providing signal instruction for line officers, and of carrying on research and practical experimentation in subjects relating to Signal Corps duties. The course at the school covered ten months, and in 1911, for example, included electricity, units and electrical measurements, dynamos, motors, batteries, transmission of power, signal engineering, submarine cables, telegraphy, radio, telephony, visual, fire control for artillery, fortification, lines of information, gas and oil engines, balloons, airplanes, photography, operation and repair of instruments, line construction, topography, languages, logistics. Throughout, the emphasis was on the practical.

Instruction for enlisted men was begun in 1912, and covered visual signaling, electricity, telegraphy, radio, line construction, and telegraph and property accounts. Prior to this time, a school of instruction had been carried on at Fort Myer, from the programs of which one can get a good idea of earlier Signal Corps education. Telegraphy, telephony, line repair, and visual signaling were taught. Operators were trained until they could receive twenty words a minute on practice lines, and then they were sent as assistants at military telegraph stations.

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These years thus had their share of stirring moments, and in the wide geographical range of the work they involved what gave the Signal Corps its first real taste of the kind of farflung activity which was so soon to be its lot on a grand scale. But perhaps the most important thing about the time between 1899 and 1916 is that it gave a perfect illustration of the Corps' motto *Pro Patria Vigilans*—which may be translated practically to mean "Keeping everlastingly at it for the Nation." For that is really what the Corps did in this period, as we have seen, and because it did so, it grew into the first Signal Corps in the modern sense of the term, and so was ready when the World War I was unleashed.

• • • — • —

Join the Signal Corps!

Sound Recording

(*Continued from page* 100)

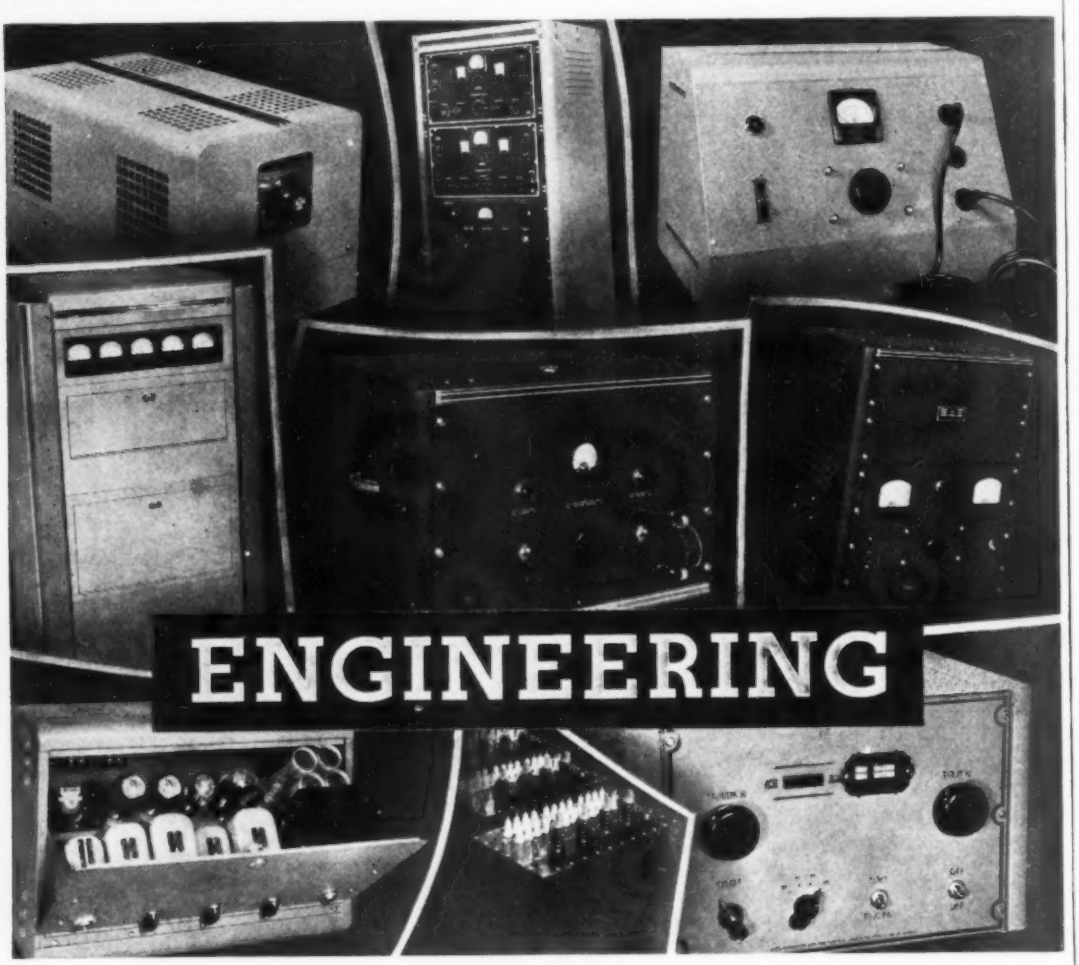
represents 100% modulation. A 45-c.p.s. filter is inserted after the compressor to remove compression thumps.

The portable channels are broken down into components mounted in sturdy portable cases, no case being too heavy for one man to move short distances or for two men easily to carry longer distances. The amplifiers and exciter lamps operate from "B" batteries and storage batteries, also in cases. The channels are normally transported in panel trucks, with the recorder and amplifier cases strapped down. Semi-permanently mounted in the assigned trucks are rotary converters driven by a 30-volt bank of heavy duty storage batteries, and supplying 220-volts AC to drive recorder and cameras. A portable control panel-distribution box is set up by the recorder, and connected to the converter start box and the driven motors with connector cables. The control box incorporates a converter field control and reed-type frequency meter on the converter output, thus enabling the recordist to adjust accurately for 60 cycle supply.

Although the channel may be operated in the truck, the portable-case mounting permits removal of all but the converter to dugouts, building interiors, etc., with a single cable running back to the converter. If extreme portability is required, the recorder motor is operated with a 12 volt DC motor powered by an airplane type storage battery.

Most field recording is done in Class "B" push-pull variable area track. Using this type of track enables the field units to make recordings having the greatest volume range without the use of noise reduction amplifiers. Noise reduction ampli-

(*Cont'd on page* 257)



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S.C. in World War I
(Continued from page 37)

This catalog of highlights in the Corps' World War I history could go on far longer; a single magazine article can by no means pretend anything like completeness. Thus far, however, we have been talking mainly about the things which Signal Corps men used — how many of this, how much of that, which was new and which was not. What about the men themselves and how they felt about the job of getting the message through? A fair answer comes out of the American attack on Bouresches in July, 1918, when Signal Corps photographers moving up to make their record of the event moved so fast that they were ahead of the infantry, and so were able to photograph the attack as it came on toward the camera. During this show, a mere strip of a lad was seen by an officer to be lying flat in a wheatfield. The boy did not appear wounded. So the lieutenant asked the natural question, to which the answer was, "Fixin' this wire, Lieutenant, that the damned Boche keeps a-breakin' all the time." It was a Signal Corps answer; the Boche might keep "a-breakin'" that wire, but the Corps man would just be on hand, and the message would go safely through.

The sort of spirit shown in these anecdotes was to the fore naturally in the St. Mihiel attack of which mention has already been made. We come back to it because it was the first offensive to be planned and directed by the Americans, because a great deal of preparatory work for it was done by the Signal Corps, and because the detective work of Signal Corps goniometric stations in locating "all enemy radio stations in their proper places on the night before the attack was the determining factor in the decision of the chief of intelligence that the enemy had not already withdrawn from the St. Mihiel salient." For this attack, army communications required the construction of 73 circuits, with 135 miles of wire.

Men of the Signal Corps with the A.E.F. in that war were awarded one medal of honor, 55 distinguished service crosses, and 40 distinguished service medals, as well as a large number of foreign decorations. These honors were won by efficiency and by courage. An interesting measure of efficiency is in these figures comparing the A.E.F. telephone system of November 1918 with typical figures representing telephone service in a large American city in June, 1918: the average operator's use of the circuit per message in the A.E.F. was 148.6 seconds, compared with 163.5 seconds for the American city. A number of measures of courage have already been suggested in this survey of the Signal Corps' part in the first World War. The attitude of the men in the field is summed up in the remark of a Signal Corps cook who had become a lineman. When a shell blew the wire out of his hand and nicked his helmet, his only comment was, "Well, I suppose I'll have to find that wire again." This signalist was a good companion to the Signal Corps private who was pulling up wire on what remained of an enemy pole. A shell struck the building which the pole touched. When the dust cleared away, there was the signalman shouting to the sergeant to bring him up one wire that had been broken, so that he could tie it in.

There is another and sterner measure of courage. The Signal Corps of the A.E.F. consisted of 1,462 officers and 33,038 enlisted men, a total strength of 34,500. Of these, 301 gave their lives, 1,721 were wounded or gassed. Percentagewise, the record of casualties of the Signal Corps stands second to only that of the Infantry in the A.E.F. Backed up by the able organization in the United States under Brig. Gen. George O. Squier, Chief Signal Officer, the men in France did their utmost in maintaining the pride of the Corps in getting the message through.

· · · — · —

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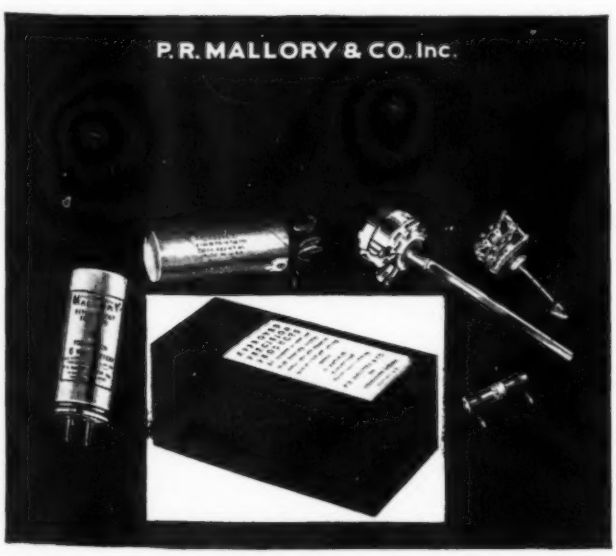

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To the challenging articles, the problems posed, the accomplishments recorded and the high spirit and purpose expressed in this dedicatory issue of RADIO NEWS, there can be but one ringing answer—*we are with you up to the hilt.*

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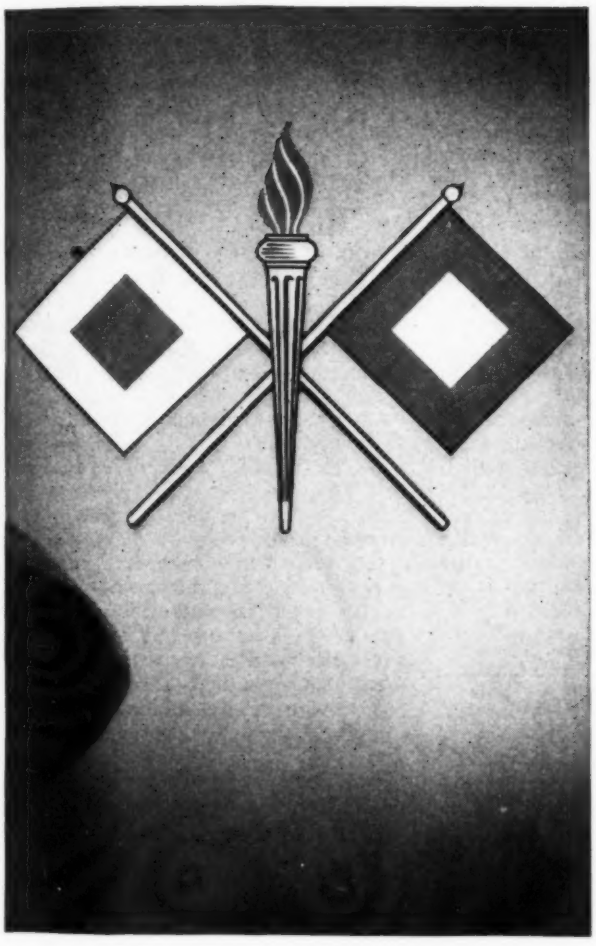

too great until the United Nations win. Let us use ALL of our industry's capacities to speed that inevitable conclusion.

In this spirit, each of us—individually and collectively—figuratively wears the insignia of the U. S. Signal Corps and our obligations are so defined.

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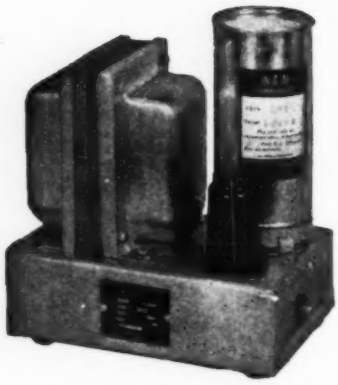

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How It All Began

(*Continued from page* 28)

and maintaining telegraphic communication between the forces in Cuba and Washington, providing visual signals for communication between coast stations and the fleet, stringing lines between the headquarters of the commanders at San Juan Hill, using balloons for observation of the disposition of Spanish forces—the Signal Corps was active in all departments of the war in Cuba and Puerto Rico. In the Philippines, new and difficult work was begun. Cable communication between Cavite and the American lines around Manila was established, and communication was maintained between the commanding general and the headquarters of his detached commands and depots. As had been true in Cuba, as the Army moved forward, the Signal Corps carried lines into the most advanced trenches. In the final assault on the defense of Manila, a field telegraph line was laid under fire to an advanced station, and the red and white signal flags were the first American emblems within the Spanish entrenchments.

Such, in swift résumé, is the story of the first half of the Signal Corps' life. During it, through the foresight and perseverence of such men as General Myer, the fortitude and strength of such men as General Greely, and the unswerving devotion to duty of the men under their command, there came into being, grew, and flourished, the tradition of alert and vigorous vigilance in defense of the nation which is the proudest heritage of the Corps.

Strong in the conviction of that tradition, the Signal Corps is facing with determination and confidence the heavy responsibilities laid upon it by World War II.

. . . — . —

The AARS Fights

(*Continued from page* 119)

amateur's value to his community has been brought to the public's attention when floods, hurricanes, earthquakes, and other catastrophes have seriously disrupted normal communication.

With the added interest of close cooperation with the American Red Cross, membership in the AARS increased steadily from about 500 in 1930 to 1,100 in 1935, 1,700 in 1939, and in 1941—as a result of a still further revised and improved plan to make the AARS an auxiliary civilian defense unit—membership climbed to around 2,500.

And then: Pearl Harbor! On December 8 the FCC, acting at the request of the Defense Communications Board, ordered the immediate suspension of all amateur radio operation in the Continental United States, its territories and possessions, until further notice. Ham bands went quieter than the proverbial tomb—and into this same state of suspended animation (no true radio amateur is ever completely off the air — mentally!) went the peacetime functions of the AARS.

And so, in reviewing the AARS and its functions and achievements, we must look backward upon a grand organization as it was. For, although the AARS as a centralized control in the Office of the Chief Signal Officer in Washington is still in existence, its "on the air activities" are very much nonexistent.

There were originally five basic objectives for the AARS, as follows:

1. To provide additional channels of communication throughout the continental limits of the United States that can, in time of emergency, be used to augment or replace the land lines, both telephone and telegraph, that may be seriously damaged or destroyed by flood, fire, tornado, earthquake, ice, riots or insurrections.

2. To place at the disposal of military commanders of all components of the Army of the United States, and of the Red Cross, such amateur radio channels of communication as may develop under this plan.

3. To provide civilian operators with a knowledge of army methods of radio procedure and of the basic principles of using radio in the field.

4. To establish contact with a considerable number of civilian radio operators, acquainting them with the Signal Corps and its activities, and securing their air in experimental work, tests, etc.

5. To render such encouragement and assistance as may be desirable to firmly establish and perpetuate the American Amateur.

To perfect a closely-knit, smoothly functioning organization like the AARS required not only close co-operation at the top, but localized contacts between Army and amateur as well. The natural tie-in was, therefore, with the nine Army Service Commands (formerly known as Corps Areas).

The Signal Officer in each Service Command appointed an officer in his headquarters to act as Service Command Liaison Agent between a representative of the licensed radio amateurs in the Service Command and the Service Command HQ. The representative of the localized radio amateurs then became known as the Radio Aide.

The Chief Signal Officer of the Army, after considering the recommendations of the nine Service Commands, appointed one transmitting amateur to be known as the Chief Radio Aide, and this individual was to function as the Army representative of all transmitting amateurs of the United States.

An Army Amateur Radio Net comprised one station in each Service Command and in each department in which amateur activities were permit-

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ted. The net control station was located at Fort Monmouth, New Jersey, and operated under the supervision of the Chief Signal Officer.

The following amateur radio nets—organized in each Service Command under the direction of the Signal Officer—were the real "work horses" of the organization, inasmuch as they carried on the actual work of message handling and formed the nucleus of available talent. Those operators who functioned within the nets were the ones who benefited most. Nets included:

a. A Service Command Amateur Radio Net comprising one station in the capital of each state in the Command. A Service Command amateur station, or a selected civilian amateur, functioned as the Net Control Station.

b. State Amateur Radio Nets were organized based on the division of each state into approximately 5 geographical areas. The stations were normally located in the principal city or town of each geographical area, or near the center of the area. The state capital station acted as Net Control Station.

c. District Amateur Radio Nets. Each comprised approximately five stations so distributed as best to accomplish the requirements. The geographical area station acted as Net Control Station for the districts.

d. Local Amateur Radio Nets. These were composed of all amateurs in local areas who were enrolled in the AARS. Local Nets operated on schedules prepared by the Net Control Station, and approved by the Service Command Signal Officer.

"ZCVA V WLM" was the call heard every Monday night at seven o'clock and it "alerted" all members of the AARS. "ZCVA" was the general call that meant that all Army "hams" should copy the test that followed. "WLM" was the special call of the Army Amateur Net Control Station W3USA located in the Office of the Chief Signal Officer in Washington, D. C. Schedules and frequencies to be used in all of the nets were announced from time to time by the Chief Signal Officer.

In a few of the Service Commands nets worked on frequencies in the 7,000—7,300 kc. amateur band, but the majority of the AARS stations functioned on the 3,500—4,000 kc. band. A separation of 2.5 kc. was used for c. w. (telegraph) nets, and 5 to 10 kc. for radiotelephone nets. Approximately one-third of all Army Amateurs were assigned to radiophone nets in the 160 meter and 74 meter 'phone bands, but all members were required to be proficient radio telegraphers, able to send or copy the International Morse Code at better than 15 words per minute. Members were given instruction in the use of Army radio procedure for both 'phone and c. w.

To generate the desired amount of message traffic in order to keep the nets active and interested, traffic of various kinds was sent from the Army Net Control Station to all Service Commands and Department Stations, which would in turn relay such portions of it to their lower nets as they deemed advisable for training. Likewise, all net control stations originated traffic suitable to their nets.

In the case of local emergencies, where the land lines had ceased to function, AARS stepped into the breach—helped in innumerable cases to get the message through on time. In such cases, the local military units were requested to protect the radio stations of the amateurs serving them, because these stations might be their only means of contact with the outside world.

The big expansion of the Army during the period prior to the closing down of all amateur stations with the outbreak of war provided plenty of opportunity for the well organized AARS, as well as for individual amateurs not directly affiliated, to be of maximum service. Thousands of messages were handled to and from the men in training at the various Army camps. In some camps Army Amateur radio stations were established by amateurs inducted into service. The co-operating amateurs relayed and delivered this service personnel traffic at their own expense as a public service—a positive contribution toward better morale.

A number of contests and tests were held frequently to test the efficiency of the AARS nets and the proficiency and reliability of the individual members. For example, the Annual Armistice Day Message Contest was held on Monday, November 10, 1941, for the active participation of the AARS nets. Each member of the nets was required to copy a message, originating in the Office of the Chief Signal Officer and transmitted by the Army Amateur NCS, WLM/W3USA, Washington, D. C., and mail a copy to his Service Command Signal Officer for checking. A "ZCB" Intercommunication Contest was usually held in the Fall and again in the Spring. Each Army Amateur endeavored on the contest night to communicate with as many other AARS stations as possible, and scores were kept. Code speed contests were run off to help operators become better operators. Other activities of similar nature were planned to maintain interest and enthusiasm at a high level.

Membership in the Army Amateur Radio System was open to every licensed amateur radio operator who had an amateur station in active operation and who could be available for the weekly drill schedules. Perhaps not so many active amateurs who should have "joined up" did so, but there is no question but that those who did obtained benefits which made them more valuable to amateur radio and to their country in time of emergency.

What the future of the AARS will be—for that matter, what the future holds for the radio amateur—no man

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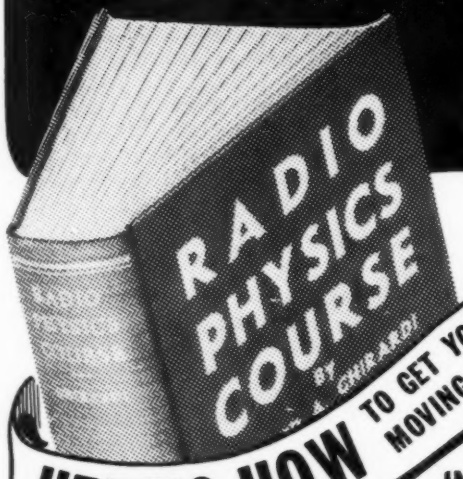

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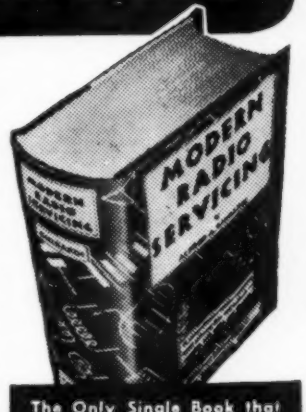

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can predict. Today and every day until the job is done, the AARS FIGHTS—fights with its fellow services on every front—fights with its specialized and highly developed talents. The number of AARS members on world battlefronts — the number of radio amateurs in active service on both the production frontiers as well as on duty "somewhere" with the Army—can only be "guesstimated." Possibly there are upward of 15,000 formerly active hams now in the khaki or the blue. Probably there are two or three times that many in industry—doing a job. And some day soon, God willing, that job will be done—successfully. Some day again "ZCVA V WLM" will ripple down the airways, and again AARS and amateur radio will be at peace under the stars. In the meantime, the AARS FIGHTS!

. . . — . —

Radio In This War
(*Continued from page* 50)

science for destruction. Only by being girded for the fight can radio be made strong to boomerang and strike down those who use it as a weapon, completely ignoring the peaceful purposes of its original creators. The genius that created for peace and civilization, also is quick to answer the challenge, quick to defend itself by enrolling to help win the war. The importance of inventive genius in modern warfare cannot be overemphasized. It is a primary factor in achieving victory.

Europe embroiled for centuries in cycles of wars has been backward in invention, in mass production, in comforts and conveniences of living. In America, under long years of peace and freedom, unhampered by the lust of conquest, radio as a science and an art has thrived. War, while its demands accelerate research and development, is not as creative as peace. For that reason, militaristic nations have forged and adapted American inventions and developments to war.

The airplane, radio, submarine, tank, motor, transport, machine gun, anti-aircraft battery, radio locators and an endless line of other inventions have been perfected by science, largely in America—the same science which brought forth television, the motion picture, the automobile and countless other things which make life more pleasant. Yet Mars, with a mighty sweep of the armored arm, pushes all up to the firing line. American laboratories, therefore, are giving their all-out efforts to equip American soldiers, sailors, marines and the forces of the United Nations with the finest radio equipment and weapons in the world, so that whether dive bombing or torpedoing, parachuting or shelling, science may protect them and give them the strongest arms of combat.

They are fighting in a war of machine against machine, armored monster against armored monster, as much as man against man. But courage plus science is a powerful force. Hence research is pitted against research, engineering against engineering, production against production, scientist against scientist whether physicist, chemist, bacteriologist, marine or aeronautical engineer. It is worker against worker; the machinist in Camden against machinist in Emden; riveter in Osaka against riveter in Detroit; factory-hand in Niagara against factory-hand in Milan. Efficiency, skill, and speed become bullets as research and industry bulwark the fighting men.

The first World War vividly indicated that radio was indispensable. From 1914-1918 America learned a vital lesson in communication. When hostilities then broke out, the United States found itself dependent largely upon British cables and foreign-owned wireless stations. The war revealed that in radio the United States could develop a new and competitive system that would make it independent of other countries in international communication, and in maintaining contact with an A.E.F. and the fleet if ever again they went overseas. The first step to gain this independence was taken shortly after the Armistice, when as the result of suggestions by Navy officials, the Radio Corporation of America was formed to give the United States preeminence in radio. Today New York is the communication center of the world. In 1918, it was London.

In the twenty-five years that have intervened between the wars, an unsurpassed radio system has been developed in the United States. Mindful of the tremendous importance and unlimited possibilities of the radio electron tube, research has concentrated upon its development. Today there are hundreds of different tubes serving many purposes. Radio research is extensive. It is closely related to the science of electronics, chemistry and physics, with metallurgy and optics. The research laboratory is a mighty fortification. In it the shock troops of modern warfare—the scientists—fight. Their weapons are infinitesimal electrons, high frequency currents, sensitive ears that hear afar, and electric eyes that see at a distance.

When America entered this conflict, it had a vast radio industry available for rapid conversion to war production. Against the background of long experience in manufacturing millions of radio sets for civilian use and apparatus for all branches of radio communication, the production lines were geared quickly to the total-war effort. In 1917, the demand was mainly limited to marine and land stations, and to field equipment. Since that time, the airplane has greatly intensified the uses of radio in warfare, and has put new demands upon engineering and manufacturing. Both are answering the call magnificently. American aircraft and ship and shore stations have

radio equipment unequaled in construction and efficiency. Constant pioneering and development of the electron tube have answered the challenges of communication in blitz warfare.

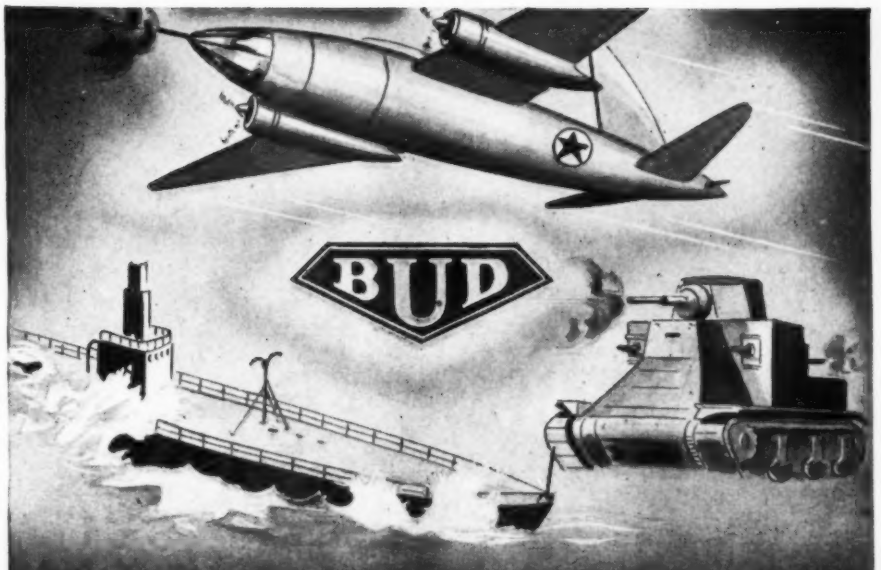
Since World War I, America has developed the finest system of broadcasting in the world. More than 900 stations are on the air, and more than 55,000,000 radio sets are in the homes of listeners. Nation-wide networks serve the country and its people. The emergencies of war reveal the tremendous importance of the networks, for in times of national emergency they quickly can be linked to reach every nook and corner of the nation. Supplementing them, hundreds of independently operated stations serve local communities.

In no other war has the American public in city and on farm been so thoroughly informed. Never before have the people had such up-to-the-minute contact with the various news fronts and news agencies. Within fifteen minutes, listeners are skipped around the world for latest reports broadcast by American observers and commentators—from Cairo to Moscow, from London to Delhi, from Australia to Iceland. The civilian population is in direct contact with the war effort, with the nation's capital and with the training camps. The War Bond campaign has been quickly put before the people and sales have been intensified, compared with the much slower campaign methods used to promote the Liberty Bonds of World War I. Radio broadcasting has responded to wartime duties, and has accepted wholeheartedly every opportunity to serve; to aid in recruiting, salvaging, rationing and instructing. Modern Paul Reveres ride the wavelengthed highways through every metropolis, village and farm to awaken and warn the people.

When the war came, there were 56,000 licensed amateur stations in the United States; in 1914 there were about 3,000. In both wars, from the splendidly self-trained group of young men who operated them, the armed services of the United States have enlisted officers and men to direct and operate wartime radio to service the equipment, and to instruct recruits. From the amateurs have come some of the ablest leaders in the field of communications. America's farsighted policy in encouraging the amateur experimenter has resulted in the enlistment of many of them in the Signal Corps, the Navy, Merchant Marine, and Air Corps.

When war was declared, television was on the threshold of becoming a service to the public. No military secret is violated in mentioning the splendid role television has played in New York through the telecasting of air-raid and civilian defense instructions. Police precincts have been equipped with receivers and thousands of air-raid wardens have been trained

(*Continued on page* 196)



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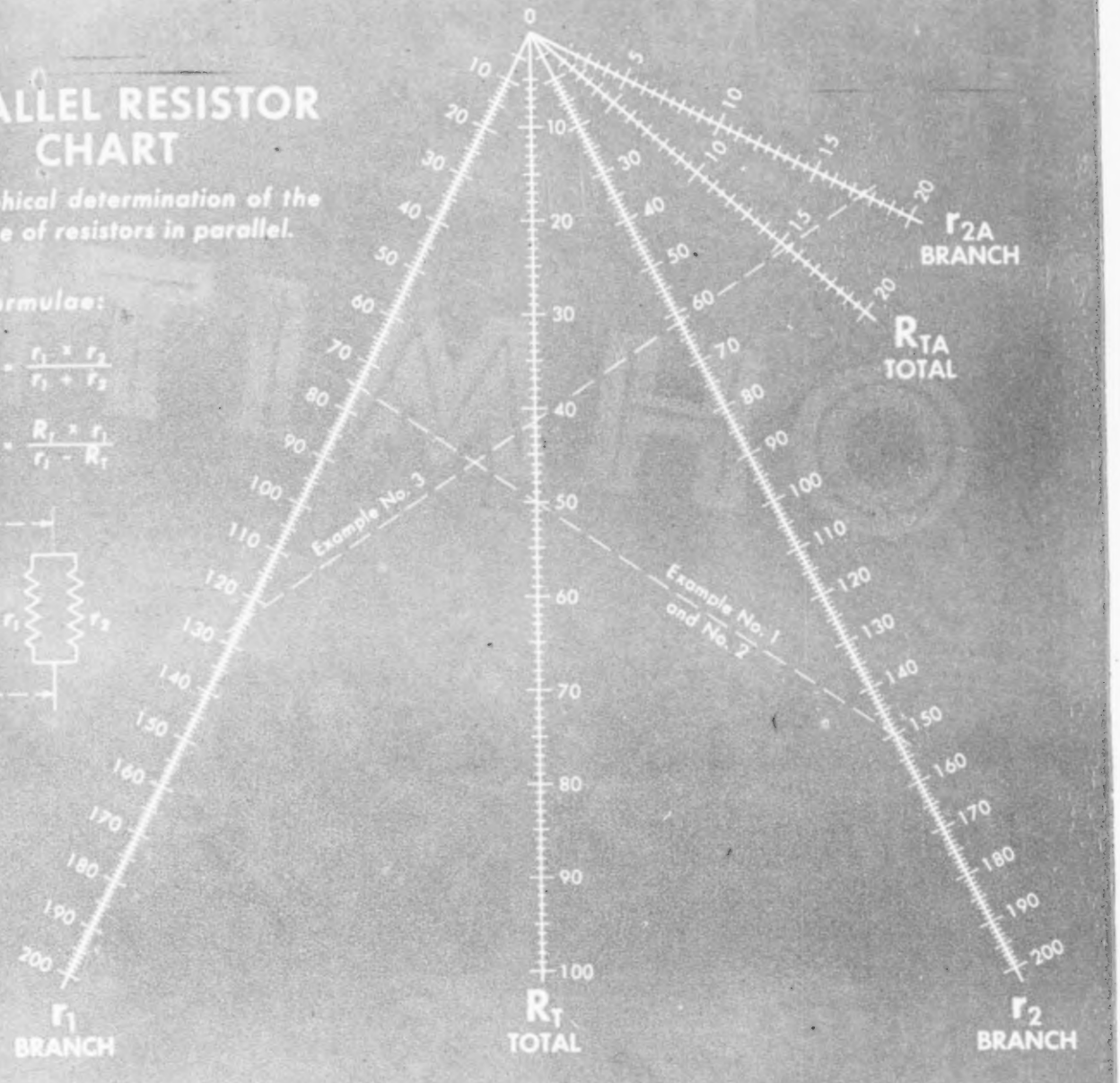
PARALLEL RESISTOR CHART

For graphical determination of the resistance of resistors in parallel.

Formulae:

$$R_T = \frac{r_1 \times r_2}{r_1 + r_2}$$

$$r_2 = \frac{R_T \times r_1}{r_1 - R_T}$$



HOW TO USE THIS PARALLEL RESISTOR CHART

This alignment chart enables graphical solution of problems involving resistances connected in parallel. The values of the parallel resistors r_1 and r_2 and of the total effective resistance R_T must be read on the scales marked with the corresponding letters. To use, place a ruler across the two known values; the point at which the ruler crosses the third scale will show the unknown value. Pairs of resistances which will produce a given parallel resistance can be obtained by rotating a ruler around the desired value on scale R_T. The range of the chart can be increased by multiplying the values on *all* the scales by 10, 100, 1000, etc., as required. Scales r_{2A} and R_{TA} are used with scale r_1 when the values of r_1 and r_2 differ greatly.

EXAMPLE No. 1: What is the total resistance of a 75 ohm resistor and a 150 ohm resistor connected in parallel? Answer: From dotted line No. 1, R_T is 50 ohms.

EXAMPLE No. 2: What resistance in parallel with 750 ohms will give a combined value of 500 ohms? Answer: From dotted line No. 1, r_2 is 1500 ohms.

EXAMPLE No. 3: What is the combined resistance of 1750 ohms and 12,500 ohms? Answer: Scales r_1 and r_{2A} are used and from dotted line No. 3, R_{TA} is 1535 ohms.

EXAMPLE No. 4: What is the combined resistance of 400, 600 and 800 ohm resistors in parallel? Answer: First find R_T for 400 ohms and 600 ohms. Then set the 240 ohms thus found as a new r_1 and 800 ohms as r_2 and the final answer is found to be 185 ohms.

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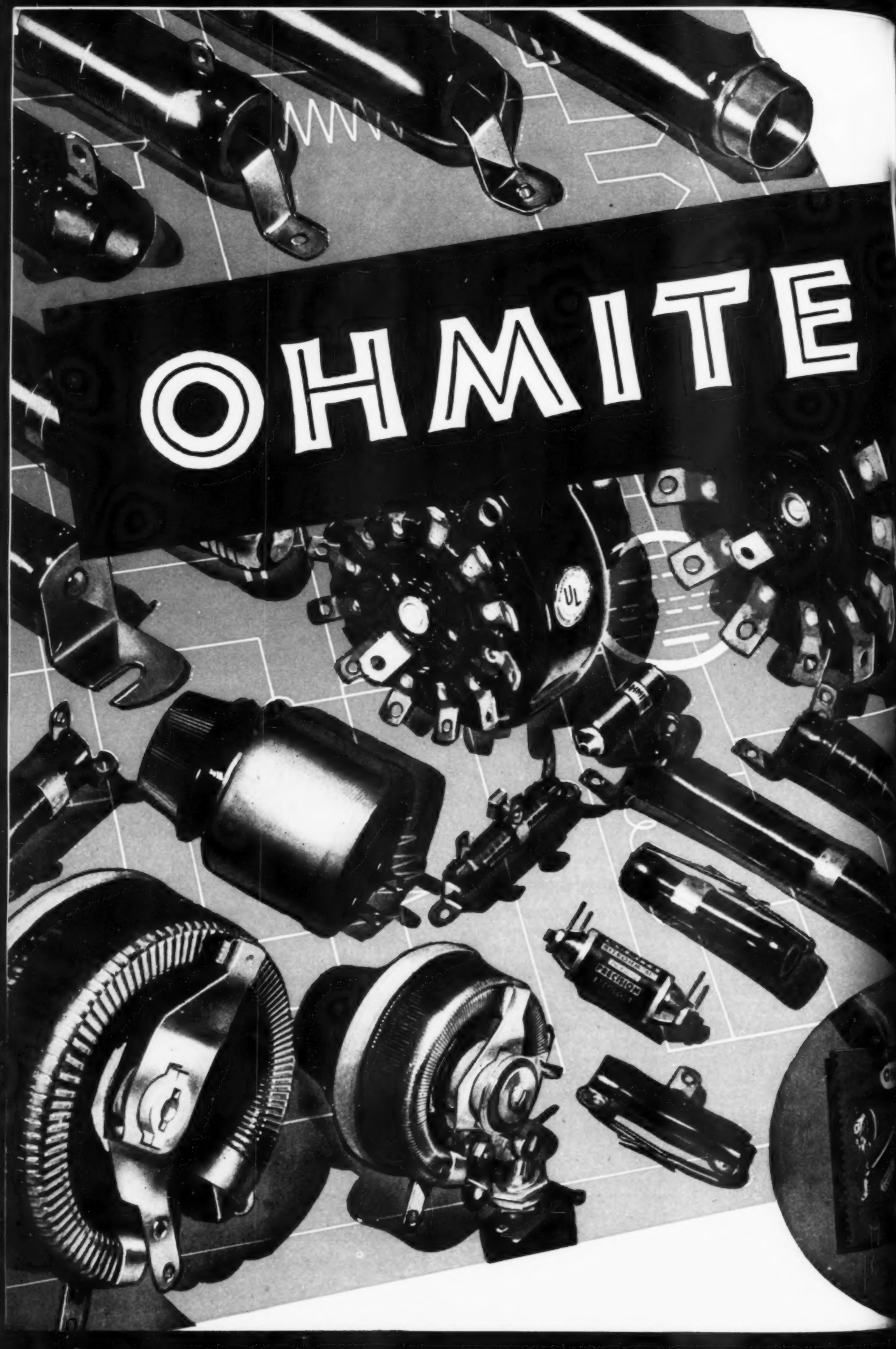
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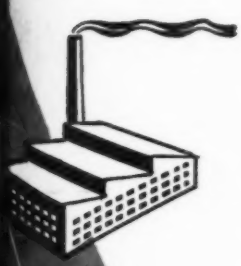

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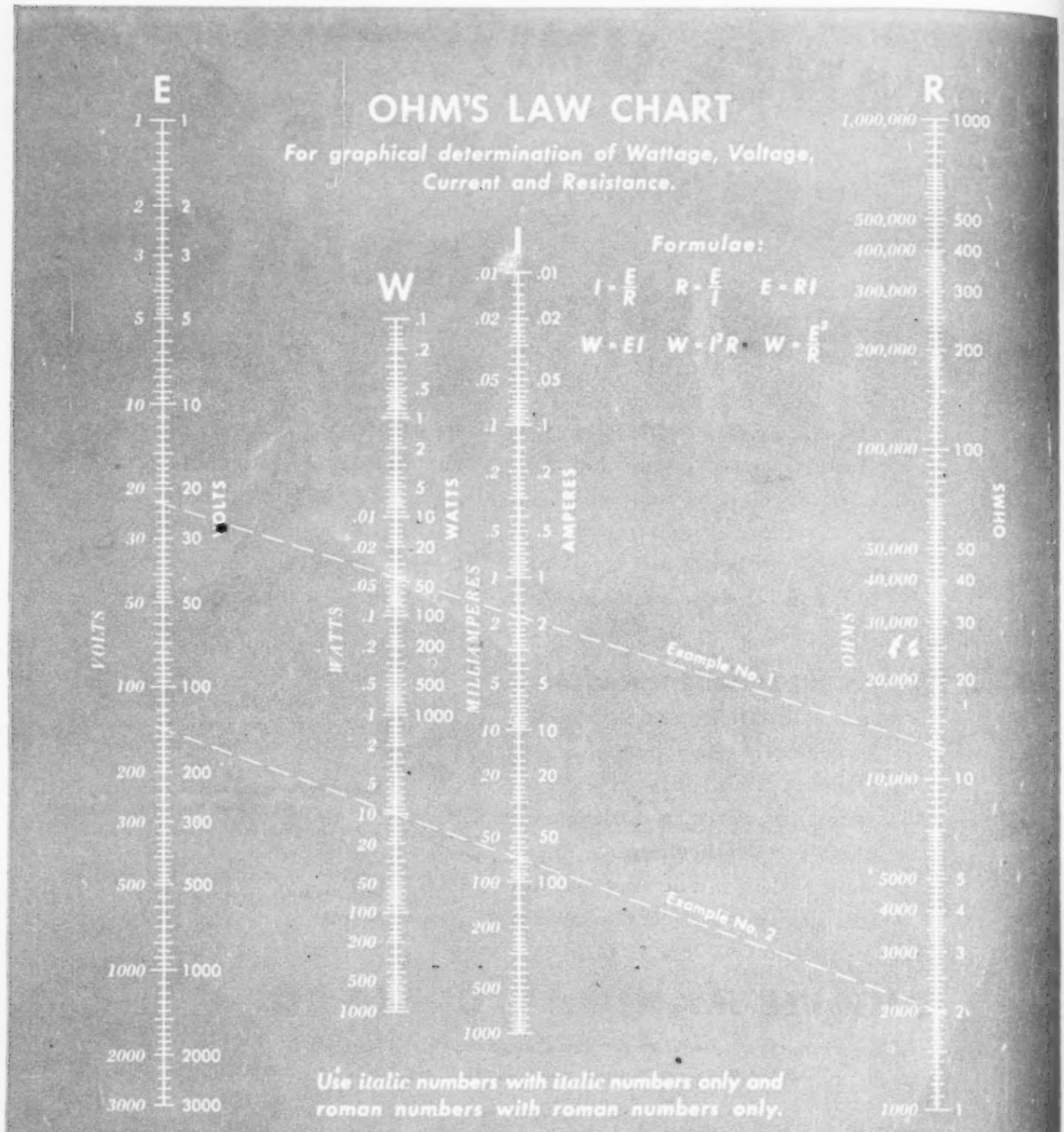


HOW TO USE THIS OHM'S LAW CHART

This alignment chart enables graphical solution of Ohm's Law problems. To use, place a ruler across any two known values on the chart: the points at which the ruler crosses the other scales will show the unknown values. The *italic* figures (on the left of the scales) cover one range of values and the roman figures cover another range. For a given problem, all values must be read either in the italic numbers or in the roman numbers.

EXAMPLE No. 1: The current through a 12.5 ohm resistor is 1.8 amperes. What is the voltage across it? The wattage? Answer: Dotted line No. 1 through $R = 12.5$ and $I = 1.8$ shows E to be 22.5 volts and W to be 40.5 watts.

EXAMPLE No. 2: What is the maximum permissible current through a 10 watt resistor of 2000 ohms? Answer: Dotted line No. 2 through $W = 10$ and $R = 2000$ shows I to be 70 milliamperes.

Courtesy OHMITE MANUFACTURING CO.

BASIC SIGNAL CORPS TRAINING

Every member of the Signal Corps receives his basic training from a series of Official Training Manuals covering all phases of Communications. For the benefit of civilians planning to enter the Signal Corps, the special insert following contains a digest of this course of training. Every radioman may increase his value to our war effort by studying those subjects mentioned.

BASIC SIGNAL CORPS TRAINING

INTRODUCTION

THE Signal Corps is engaged in one of the nation's greatest educational ventures. In order to ensure that the modern devices of communication which it has put in the field shall be properly operated and adequately maintained, the Signal Corps must impart the knowledge of electrical fundametals and of radio technology to tens of thousands of civilians and soldiers. It prefers men with previous radio experience, but it also trains many who may never before have plugged a vacuum tube into a socket—provided they have the necessary aptitudes.

This program of training has overflowed from the military Replacement Training Centers and service schools of the Signal Corps into a large number of civilian institutions. These civilian schools, ranging from the "mechanic learner" level to that of the engineering college, have two functions: the training of civilian employees for the domestic installations of the Signal Corps and the training of men who will become soldiers of communication. The latter function is growing in scope.

The civilian training program is closely interrelated with the military training program. Uniformed soldiers of the Signal Corps are often assigned for special studies to civilian technical schools. Again, thousands of young men of military service age are enrolled in the civilian training schools and placed for a limited period in the Enlisted Reserve, so that they will be called to active duty with the Signal Corps upon completion of their courses—or, if necessary, before their completion. The training program at the Signal Corps schools for enlisted men is so arranged that those with previous training in signal communications can be excused from courses which they had already covered in civilian life and can progress through the remaining courses as rapidly as their experience and abilities permit. Thus the graduates of civilian schools gain a head start in their military careers.

The civilian training program also provides for men and women destined to serve in a civilian capacity as mechanics, inspectors, maintenance men and engineering aides in the many Signal Corps Procurement Districts, Depots, Shops and Laboratories. Tens of thousands of civilians are employed in these installations.

The program of training in civilian schools includes a number of courses in which the students are hired as Civil Service employees and are paid while engaged in their full-time studies. Other courses are given on a part-time basis in evening schools, with tuition supplied free at government expense.

The content of these courses has naturally varied as the program has developed and as the needs of the Signal Corps have grown and changed. The curricula are likewise subject to change in accordance with the availability, under current priorities, of the equipment needed for laboratory experiments. Again, with many schools working in cooperation with the Signal Corps and the United States Office of Education, new techniques of teaching are being constantly worked out and incorporated in the program, so as to produce better technicians in less time.

For these reasons, any statement of the exact curriculum is likely to be obsolete in some respects shortly after its publication, or even before.

However, to provide prospective enrollees with an idea of the training that will be encountered, and the degree of preparation required to enter the various levels of the training program, this supplement presents examples of the various military and civilian training courses conducted or sponsored by the Signal Corps, as they stood at the time this special issue of RADIO NEWS went to press.

Every student must learn how to handle all kinds of tools as part of his training. Many of these men have never had previous practice in shopwork.

This basic outline for prospective Signal Corps students will enable them to brush up on subjects needed to qualify as wire and radiomen.

BASIC SIGNAL CORPS MILITARY TRAINING

AT THE three Signal Corps Replacement Training Centers—Fort Monmouth, Camp Crowder, and Camp Kohler—the newly inducted Signal Corps private spends his first four weeks in the basic training program prescribed for all troops of the Army Services of Supply. This includes lectures on the Articles of War, the Organization of the Army, military discipline, customs and courtesies, military sanitation, hygiene, and first-aid. It gives the soldier many hours of practice in infantry drill, rifle marksmanship, and defense against chemical attack, air attack and mechanized attack. The basic schedule also provides for marches and bivouacs, field fortification practice, night operations, guard duty and physical training.

In addition to these basic stages in the making of a soldier, the Signal Corps man, whether he is subsequently selected for specialized work in either wire or radio, receives certain fundamental training in the basic elements of signal communication. He must master the simple tools and methods of making electrical connections. These include the use and care of the electrician's knife, screw driver and pliers; testing dry cells; connecting batteries; the making of proper wire splices; connecting, using and testing of field telephones; and the laying of grounded or metallic circuits between two telephones.

Even a man with considerable radio experience in private industry can usually be shown that his technique of wire splicing, for example, can be improved and that his speed in making a splice can be increased. The Army has standardized methods of measuring the length of wire to be stripped for a splice, of removing insulation, of forming reliable contacts, and of reapplying the insulation to insure a neat and reliable splice through which the signal can pass as freely as if the wire were a continuous length. Continued practice develops such dexterity that the soldier can almost automatically splice a wire under any conditions.

The fundamentals of connecting telephones and power sources serve as an introduction to the more advanced circuits which are encountered in the specialty schools of the Replacement Training Centers. Beyond this stage is admission to one of the Signal Corps Schools, which give advanced specialized training to officers and men. The courses offered in the Enlisted Men's Department of the Eastern Signal Corps School are outlined in the following section of this supplement.

ENLISTED MEN'S COURSES AT THE EASTERN SIGNAL CORPS SCHOOL, FORT MONMOUTH, N. J.

The following outline of the technical training program in the Enlisted Men's Department of The Signal Corps School has been condensed from an official Instructional Circular of The Eastern Signal Corps School. Methods used at Signal Corps Schools in the newer camps are similar to those set up at Fort Monmouth.

The principal courses for enlisted men conducted at The Eastern Signal Corps School are:

(1) Radio Communication; (2) Wire Communication.

Listed below are the different specialties of the two courses.

The *Radio Communication Course* includes the following specialties:

Radio operator, field station; Radio operator, fixed station; Radio repairman; Teletypewriter operator.

The *Wire Communication Course* includes the following specialties:

Cable splicer; Central office repairman; Installer-repairman, local battery; Installer-repairman, common battery; Line foreman; Powerman; Switchboard installer (manual); Wire chief, local battery; Wire chief, common battery; Teletypewriter maintenance man.

Method of Instruction

The applicatory method of training is employed in the Enlisted Men's courses of The Signal Corps School, following closely the methods employed by the leading civilian vocational institutions. The students are taught correct principles and methods and their practical application. The greater part of the instructive time is devoted to practical work covering the requirements of the particular job in which the student is receiving training. Until they have successfully completed a given phase of instruction, students will not be permitted to progress to a more advanced phase. A partial objective in all instruction is the preparation of the student to act as instructor, when necessary, upon re-

Many assorted tools are used by Radio and Wire students. They learn correct use of them under the expert guidance of skilled radio and mechanical craftsmen.

This may be your future code room.

turn to his organization. This is accomplished in part by the student's observation of the instructional material and methods in the School. When the nature of the specialty permits, the student is also given practice in acting as instructor before leaving the school. Non-commissioned officer students are given a special course in "Teaching Methods."

Grading—Credits—Personal Ratings

a. Academic grades. At the conclusion of each sub-course, pertaining to a specialty, students will be required to take a final examination therein. A grade of at least 70 percent is required to satisfactorily complete a subcourse.

b. Credits. Any student having adequate knowledge of any of the subcourses, upon entering the school, may be exempted from the work required to complete such subcourses by the assistant commandant upon recommendation of the director, Enlisted Men's Department.

c. Personal ratings. Instructors will rate each student in each subcourse on the qualities he demonstrated in class. The ratings for each quality will be the standard War Department Efficiency Report ratings of: unsatisfactory, satisfactory, excellent, and superior. These ratings will be consolidated on the student's final report card.

Certificates

Certificates are awarded to students who satisfactorily complete all subcourses pertaining to any one specialty, and who obtain satisfactory personal ratings.

Instructors will teach you how to use typewriter.

RADIO COMMUNICATION COURSE

The objective of the Radio Communication Course is to qualify personnel in one of the following specialties.

a. Radio operator, field station.
b. Radio operator, fixed station.
c. Radio repairman.
d. Teletypewriter operator.

Radio Communication Subjects

The subcourses required for each specialty are as follows:

Radio Operator, Field Station. International Morse Code Alphabet, Field Station Traffic, Installation and operation of field radio nets, and Radio procedure (Field Nets).

Radio Operator, Fixed Station. International Morse Code Alphabet, Fixed Station Traffic, Operation of fixed radio station equipment, Radio procedure (Fixed Nets), and Touch typing.

Radio Repairman. Principles of electricity, Shop Work, Elements of radio, and Test and repair of field radio equipment.

Teletypewriter Operator. Touch typing, Teletypewriter procedure, and Teletypewriter traffic practice.

Analysis of Radio Communication Subcourses

Principles of Electricity. Instruction is of a practical nature and covers the basic principles of electricity and magnetism which will enable the student to understand the circuits and functioning of field radio equipment.

Radio Shop Work. Instruction covers the use and care of the tools commonly employed in the repair of field communications equipment. Instruction is entirely practical.

Radio Code Practice

(a) *International Morse Alphabet.* Instruction is practical and covers practice in transmitting and receiving radio telegraph signals in the International Morse alphabet until the student is able to copy ten (10) words per minute.

(b) *Field Station Traffic.* Instruction is practical and is intended to familiarize the student with field message forms while increasing his operating speed to 20 words per minute.

(c) *Fixed Station Traffic.* Practical instruction intended to familiarize the student with message forms as used in fixed nets while increasing his code speed to 35 words per minute. The typewriter is employed.

Installation and Operation of Field Radio Nets. Instruction covers the installation, adjustment and operation of field radio sets, in field nets.

Elements of Radio. Instruction covers the elementary principles of radio theory and of basic radio circuits. Instruction is made practical by requiring the student to construct and analyze the different types of basic radio circuits.

Test and Repair of Field Radio Equipment. Instruction covers a detailed study of circuits and testing of field radio equipment. This is followed by actual practice in the maintenance of this equipment.

Operation of Fixed Radio Station Equipment. Instruction covers the operation of fixed nets. The object of this course is to develop skill in handling traffic and to give practice in the operation of permanent station equipment. Messages of the form transmitted over the War Department Net are used for instructional purposes. In addition, students are given practice on Wheatstone automatic transmitter tapes, the transmission of same and the reading of ink recorded tapes.

Radio Procedure

(a) *Field Nets.* Instruction covers the procedure and methods employed by radio operators in sending and receiving field radio messages and includes practical application on table nets.

(b) *Fixed Nets.* Instruction covers the proper procedure and methods employed by radio operators in sending and receiving radio messages in fixed radio nets.

Touch Typing. Instruction and practice in the use of the typewriter, using the touch system.

Teletypewriter Procedure. Instruction covers the procedure and the methods employed in sending and receiving messages by telegraph printer.

Telegraph Printer Traffic Practice. Practical instruction in the handling of traffic between two or more telegraph printers.

Teaching Methods. A study of the theory of approved

teaching methods, including practice teaching. This subcourse is given to non-commissioned officers among the students.

WIRE COMMUNICATION COURSE

The objective of the Wire Communication Course is to qualify personnel in one of the following specialties:

a. Cable splicer.
b. Central office repairman.
c. Installer-repairman, local battery.
d. Installer-repairman, common battery.
e. Line foreman, lineman.
f. Powerman.
g. Switchboard installer.
h. Wire chief, local battery.
i. Wire chief, common battery.
j. Teletypewriter maintenance man.

Wire Communication Subjects

The following are the subcourses taught in the specialties listed above:

Cable Splicer. Pole line construction and Cable splicing.

Central Office Repairman. Principles of electricity, Shop Work, Common-battery line and subset circuits, Common-battery switchboard circuits, and Central Office maintenance.

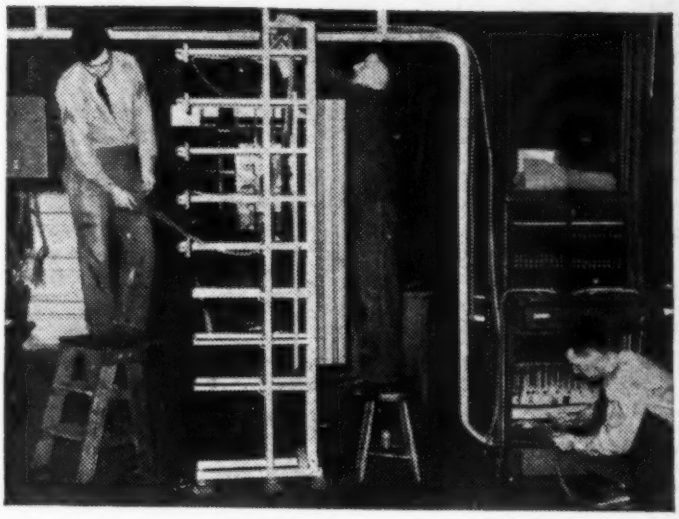
Installer-repairman local battery. Principles of electricity, Shop Work, Technique of field wire systems, Repair of field wire equipment, and Local-battery telephone and switchboard circuits.

Installer-repairman common battery. Principles of electricity, Shop Work, Substation installation, Substation maintenance, and Common-battery line and subset circuits.

Line foreman, lineman. Shop Work, Pole line construction, and Technique of field wire systems.

Powerman. Principles of electricity, Shop Work, and Power equipment maintenance.

Switchboard installer. Principles of electricity, Shop Work, Central Office installation, Common-battery line and subset circuits, and Common-battery switchboard circuits.



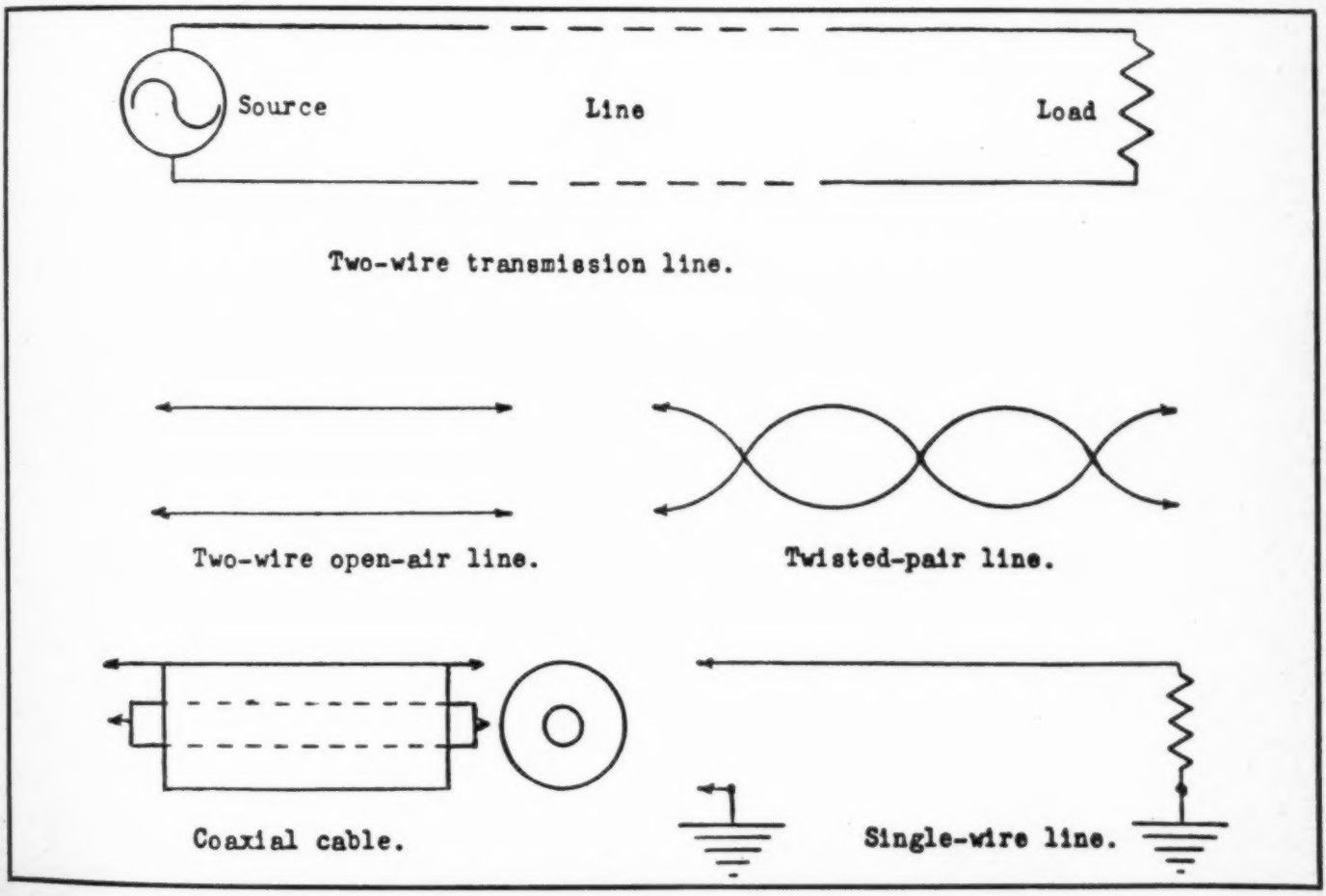
You, as a wire student, can learn telephone theory.

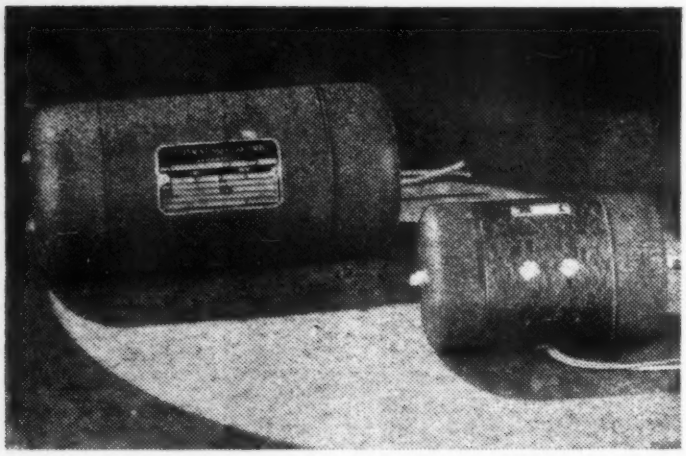
Wire Chief, local battery. Principles of electricity, Technique of field wire systems, Repair of field wire equipment, Field telegraph circuits, and Local-battery telephone and switchboard circuits.

Wire Chief, common battery. Principles of electricity, Central Office installation, Common-battery line and subset circuits, Common-battery switchboard circuits, Central Office maintenance, and Cable maintenance.

Teletypewriter maintenance man. Principles of electricity; Teletypewriter maintenance, No. 14 Teletype printer (as required); Teletypewriter maintenance, No. 15 Teletype printer; Telegraph printer maintenance, No. 19 Teletype printer; Telegraph printer maintenance, Teletype keyboard-perforator, transmitter-distributor and reperforator; and

These are electrical circuits for various types of transmission lines used between transmitter and antenna.





You will learn all about motors and generators.

Telegraph printer maintenance, No. 26 Teletype printer (as required).

Analysis of Wire Communication Subcourses

Principles of electricity. Instruction covers the elementary principles of electricity and magnetism which will enable the student to understand the functioning of telephone circuits and associated electrical equipment.

Shop Work. Instruction covers practice in the use and care of tools ordinarily required by telephone linemen and maintenance men.

Substation installation. This subject covers instruction and practice in standard methods of installing common battery substation equipment, from the cable terminal to and including the subset.

Central Office installation. Instruction and practice is given in post and field type common battery central office installation. The student will perform all work required, including installation of necessary cables, main frame, power panel and test cabinet.

Switchboard operating. The instruction covers standard methods and practices of handling such calls as may originate at common battery switchboards in both field and post telephone systems.

Substation maintenance. Instruction is given in the causes, diagnosing and clearing of trouble, in the subscribers line circuits and equipment, from the main frame to the subset, inclusive.

Pole line construction. This subject covers instruction and practice in the placing of both open wire and cable plant and the necessary supporting structure.

Cable Splicing. This course covers instruction and practice in testing, splicing and wiping joints, and the performance of a cable splicer's duties under working conditions.

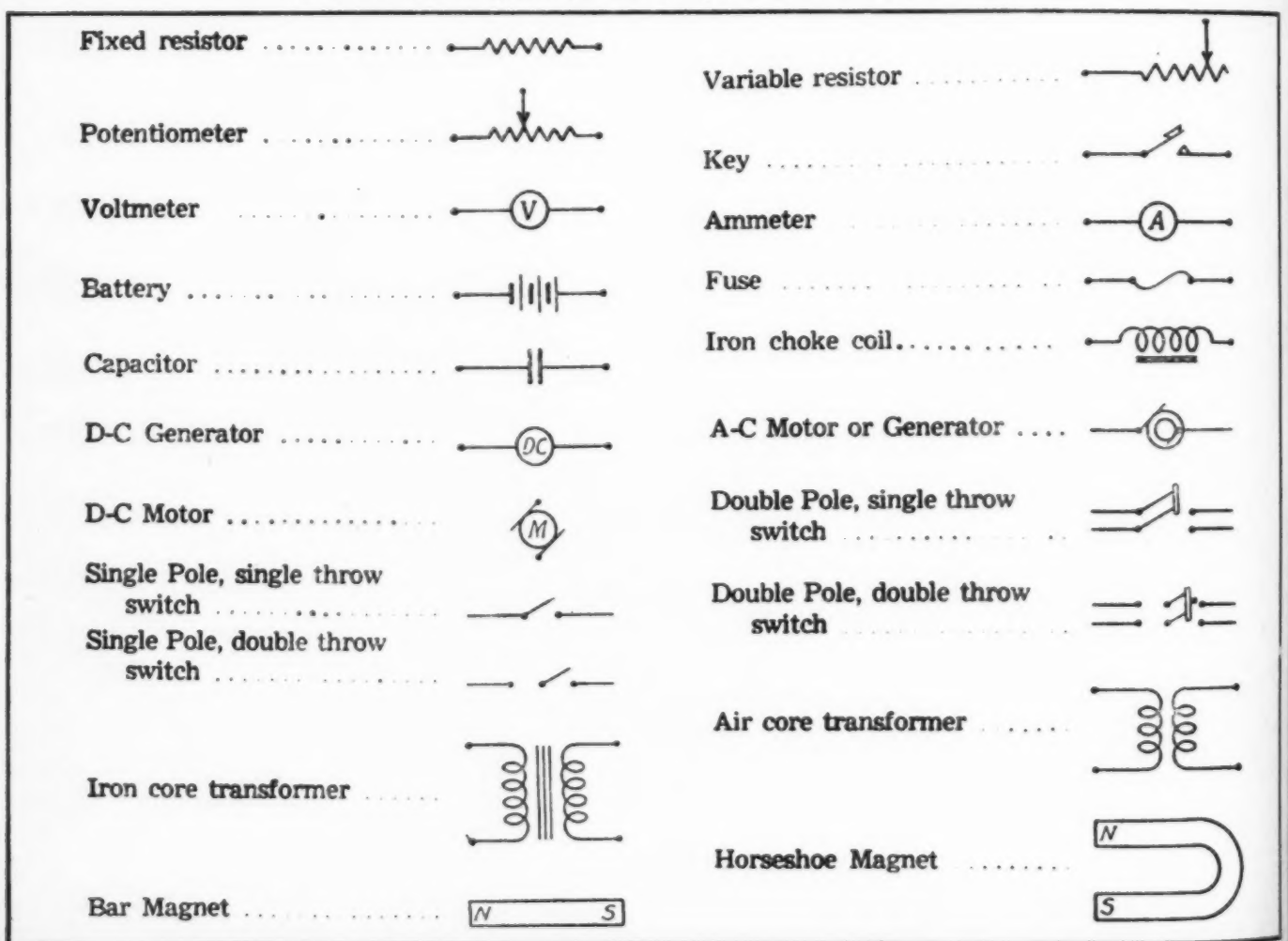
Technique of field wire systems. Instruction and practice in the installation, operation and maintenance of the field wire systems used in a division or smaller unit.

Repair of field wire equipment. Instruction covers the locating of troubles and the repair of telephone and telegraph equipment used in local-battery field wire communication systems.

Field telegraph circuits. This subject covers the principles of open and closed circuit telegraphy and a detailed study of the telegraph equipment now in use with field organizations.

Local-battery telephone and switchboard circuits. Instruction covers the fundamental theory of basic local-battery telephone, line switchboard and testing apparatus and of the equipment used in local-battery field systems.

These are electrical symbols you must study and use when drawing circuits.



Common-battery line and subset circuits. Instruction covers the fundamental theory of operation of common-battery substation and central office line circuits.

Common-battery switchboard circuits. Instruction is given in the theory of operation of circuits and apparatus of common-battery manual switchboards, and associated equipment, with special emphasis on the types employed by the Army on post and field telephone systems.

Teletypewriter maintenance

(a) *No. 14 Teletype printer.* This machine is of the tape type. The course covers a study of the functioning, disassembly and reassembly, trouble analysis and maintenance. Each student is required to clear fifty cases of trouble.

(b) *No. 15 Teletype printer.* This machine is of the page type which employs a moving type basket. The course covers a study of the functioning, disassembly and reassembly, trouble analysis and maintenance. Each student is required to clear seventy-five cases of trouble.

(c) *No. 19 Teletype printer.* This unit consists of a No. 15 printer, less its keyboard, to which has been added a perforator-transmitter and an automatic transmitter-distributor. The course covers a study of the functioning, trouble analysis and maintenance of all items excepting the typing unit which is covered in subcourse 215b. Each student is required to clear twenty-five cases of trouble.

(d) *Teletype keyboard-perforator, transmitter-distributor and reperforator.* These units are used in punching the tape and in transmitting from the perforated tape. The course covers the functioning, trouble analysis and maintenance of the various units. Each student is required to clear twenty-five cases of trouble. Work on the transmitter-distributor is not repeated if it has already been completed in subcourse 215c.

(e) *No. 26 Teletype printer.* This machine is of the page type which employs a type wheel. The course covers a study of the functioning, disassembly and reassembly, trouble analysis and maintenance. Each student is required to clear fifty cases of trouble. This course is given only to proficient men from organizations already equipped with the No. 26 printer.

Central Office Maintenance. Instruction and practice is given in the maintenance and operation of common-battery telephone exchanges including main frames, power equipment, testing equipment and records, also in locating and clearing troubles in central office apparatus and in routine maintenance practices.

Cable maintenance. This subject covers instruction and practice in the use of equipment for determining the nature and location of trouble in cables.

Power equipment maintenance. This covers instruction in the installation, operation and maintenance of telephone power equipment used for both permanent and field type central offices, and the care and operation of various types of gasoline engines used to drive portable generators.

Teaching Methods. A study of the theory of approved teaching methods, including practice teaching, for non-commissioned officers.

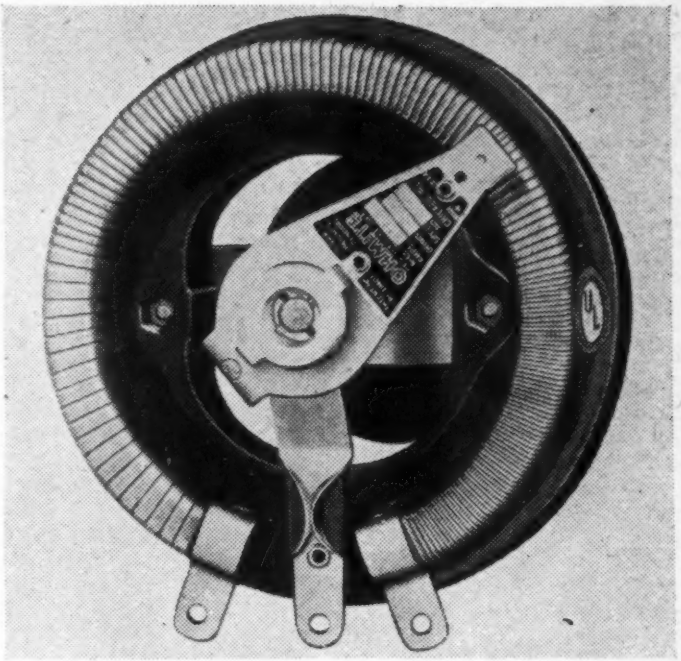
TRAINING THE RADIO OPERATOR

The training of radio operators in a uniform procedure of sending and receiving International Morse code is highly important. All the difficult and dangerous work that is involved in setting up field radio stations and keeping them in repair is directed towards one goal—getting the message through—and that goal is actually achieved by the man at the key.

Many of our amateur radio operators have joined the Signal Corps or other components of the armed forces where their services were urgently needed, but the Signal Corps needs many more. It must train thousands of men who may not have known the difference between a "dit" and a "dah" before they entered the Army.

To train these men rapidly and yet with sufficient thoroughness so that they can send and receive high-speed code almost automatically under conditions of stress, the Signal Corps has developed efficient methods of instruction based on the findings of experienced radio operators and educators.

The average amateur radio operator may have learned code in a casual way—by practicing in odd moments, by



Heavy duty rheostats—used in transmitter equipment.

straining to understand the messages picked up on the pre-war short wave channels. The Signal Corps operator learns his International Morse in a way that has been carefully planned to instill correct habits from the start and to develop speed and accuracy in a regular progression of systematic steps.

How this system of instruction is applied can be understood by studying the following material, which has been abstracted from Technical Manual 11-454, issued by the War Department under the title "The Radio Operator."

SELECTION OF PERSONNEL

GENERAL—It is essential that the code learning ability of prospective students be determined prior to instruction, because the length of time required to train an operator varies, depending upon the individual's ability. Consequently, all personnel to be trained will be selected by the use of some form of test or tests. The best test is, of course, a learning period consisting of actual code practice lessons. When time will not permit such a learning period, the aptitude test, as herein described, or other tests, will be used.

RADIOTELEGRAPH OPERATOR APTITUDE TEST—This test has been used for many years by schools and units

Simple board layouts show how wires are connected to parts.

of various arms and services. It is designed to determine the individual's aptitude to learn the International Morse Code by sound. This is accomplished by requiring the student to indicate whether or not certain tone signals sound exactly alike. For best results, the tests should first be administered to the prospective students and THEN REPEATED IN EXACTLY THE SAME FORM within a few minutes. It has been shown that a more accurate measure of the man's ability is secured by playing the records through twice and using the average of the two scores. Thus the scores on each test for each individual should be added to obtain his final raw score.

GENERAL CLASSIFICATION TEST, U. S. ARMY—This test is designed to provide a quick measure of how well a man can learn the duties required of a soldier rather than the amount of knowledge he has acquired. The test is not designed to indicate how quickly a man can learn code, but rather to provide information on how quickly a man can master the non-code essentials, such as radio procedure, methods of signal communication, operation of radio sets, and other technical subjects. However, very few men having standard scores below 90 on this test will be able to learn quickly the various duties required of a radio operator.

OTHER TESTS—The War Department conducts studies to determine ways and means of selecting men to be trained as radio operators in a minimum amount of time. These studies result in tests which are issued from time to time with instructions for their proper use. They may supersede or be used in conjunction with the present tests, as prescribed.

SUGGESTIONS FOR INSTRUCTORS

GENERAL—In teaching radio operators it must be recognized that the mental processes and mental habits of a student play a very important part. That is, students will learn most rapidly when correct mental habits are developed by using proper mental processes. This section deals with the mental habits and mental processes of the student from the instructional point of view.

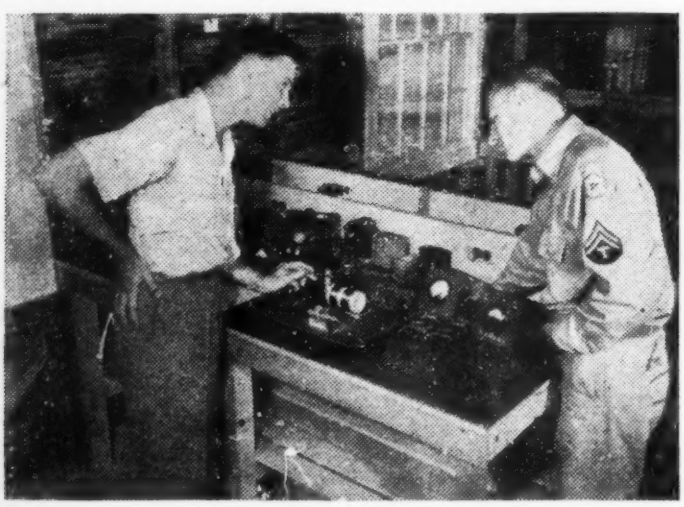
SPEED OF CHARACTER TRANSMISSIONS—In order to prevent the student from learning the code by counting dots and dashes, the characters are always transmitted at a rate employed by operators when sending 20 to 25 words per minute. However, the space between characters is such that only four words are transmitted each minute. This comparatively high speed transmission of characters results in the student learning the characters by sound only. In so doing a reflex action is developed. This action of hearing a character and immediately recording it becomes automatic. The operator learns to hear the sound and immediately register the character without any mental effort. It is this effortless reflex action that makes a good radio operator.

RADIO OPERATOR'S COURSE—A radio operator's course should contain the following elements:

a. Code training. (Radio, telegraph, and light signals.)

b. Radio procedure training.

Learning by doing is encouraged in the classroom.



c. Auxiliary training.

CODE TRAINING—USE OF DISTRIBUTED PRACTICE—*a.* It is recommended that not more than two successive 50-minute periods be devoted to straight code practice at any one time, and that only one 50-minute period at a time be so used until the alphabet is mastered. A 10-minute recess at the end of each class hour is recommended.

b. Not less than two nor more than five periods a day should be devoted to code practice. Three or four periods a day probably will prove to be the most satisfactory.

c. If the minimum time of two periods a day is to be used, it is recommended: (1) that the practice period be separated by at least two periods devoted to non-code material, or (2) that if the schedule requires code practice during the morning or afternoon only, both periods be given in the morning and separated by at least one period devoted to non-code material.

d. The division of code practice suggested above should reduce monotony and at the same time provide periods of maximum length under which sufficient training may be expected to take place.

CODE TRAINING—USE OF SELF-CHECK PROCEDURES—All student responses, especially during the first phase of training, should be checked frequently so that no student will make the same error repeatedly. This is important, and it is necessary that instructors give personal attention to all students.

CODE TRAINING—RELATIVE AMOUNT OF TIME SPENT RECEIVING AND SENDING—

a. During the mastering of the alphabet, most of the code practice time should be devoted to receiving, observing correct printing practice, and familiarizing the student with the "feel" of the key.

b. While the students are working at code speeds from six to eight words a minute, it is recommended that 25 percent of the time be devoted to sending practice. Students should be carefully supervised by the instructors to insure the development of the proper sending habits.

c. After a student is able to receive eight words per minute correctly, it is recommended that about 25 percent of the time be devoted to sending to other students. The instructor should monitor these student-to-student two-man class nets, carefully checking the sending speed and the formation of the characters.

CODE TRAINING—ATTAINING SPEED IN RECEIVING AND SENDING—

a. Attaining speed in receiving and sending is acquired only by constant practice when the student has acquired the proper mental habits. It is recommended that formal two or three minute tests be administered so the student will learn to work accurately under pressure. A suggested passing mark on each test is not more than one error per minute of test material, the test items being presented at the code speed for which a man is qualifying.

b. The speed tests for students qualifying at five words per minute or more should be made up of the required number of characters selected at random from a pool of items composed of four complete alphabets (4 x 26 letters) and two complete sets of numerals (2 x 10 numbers). No test should be used more than once. The instructor should monitor these tests in order to insure that the proper code speed is maintained.

BASIC INSTRUCTIONS TO STUDENTS

INTERNATIONAL MORSE CODE—*a.* In the International Morse Code all letters, numerals, and punctuation marks are represented by combinations of long and short sounds. The long signal is a dash. For verbal discussion it is pronounced "dah." The short signal is a dot. Verbally it is pronounced "dit." These signals may also be transmitted visually by flashing a lamp for long and short periods respectively, or as positions of a flag to the right and left of the flagman as in wig-wag. The process of receiving consists of recognizing these combinations of dots and dashes and recording the characters they represent. This manual is concerned primarily with the instruction of students in recording dot and dash characters as received by ear and in transmitting similar signals by means of manually operated telegraph keys.

b. In the International Morse Code, the dots, dashes, and

spaces have the following relative length:

(1) A dot is used as the unit of duration.

(2) A dash is equal to three units.

(3) The space between parts of any character is equal to one unit.

(4) The space between any two letters or characters is equal to three units.

(5) The space between any two words or groups is equal to seven units.

SUGGESTIONS FOR STUDENTS—The basic requirements in learning to receive are: (1) concentration, (2) practice, (3) confidence, and (4) patience.

(1) CONCENTRATION—This is of the utmost importance. When practicing code, clear your mind of everything else. Permit nothing to interrupt you. Learn to concentrate strictly on the work immediately at hand. Speed and proficiency in mastering the code depends largely upon yourself, your ability to concentrate, and the amount of effort you apply. Concentration is vitally important when you are first starting to learn the code. You must get the characters firmly fixed in your mind during the primary lessons, and this requires every ounce of concentration you can apply. You cannot easily "catch up" later on, as the speeds will be greater. Don't let "outside" noises distract you. Keep your mind on the signal you are copying. If local room noises occur, try to disregard them, pay no attention to them. Concentrate only on what you are copying.

(2) PRACTICE—Progress in code reception will be directly proportional to the amount of practice you apply. Acquiring speed is mostly a matter of intelligent practice. The student with a natural sense of tone and rhythm will probably advance much faster than the student who must cultivate this faculty. *No matter what speed* the important factors are: spacing, rhythm, and balance. Perfect sending at slow speeds is very difficult, but perfect sending at any speed always makes the speed sound slow. Develop your sense of timing and rhythm by "talking" in code; by whistling or sounding the characters by voice or tapping them out. If code transmissions are available, listen to them and try to recognize and copy words or characters.

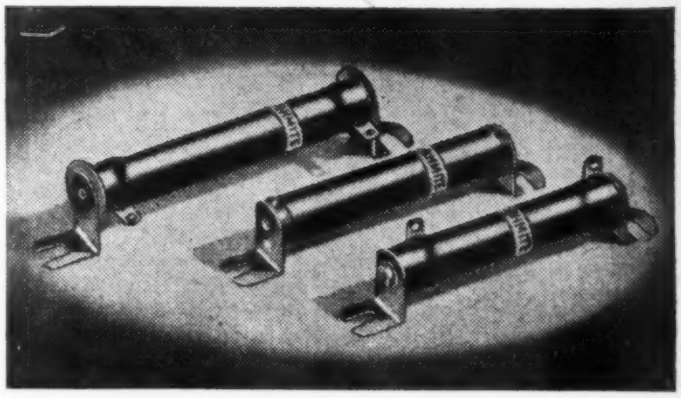
(3) CONFIDENCE—From the start, resolve that you are going to master the subject of code reception. Do your best at all times. Never permit yourself to become discouraged over your progress. If you are slower than other students do not let it worry you. Some of you will make better operators than those who learn rapidly at the beginning. Do the best you can and never give up.

(4) PATIENCE—Don't become impatient regarding the time it may take you to learn the code. You may reach certain speeds above which you find it difficult to progress. If this occurs don't feel that you are lost. Keep plugging steadily and you will succeed. For every student there are certain speed levels where temporary "stagnation" occurs. You may find yourself standing still for as long as three or four days. Just be patient, apply yourself conscientiously and you will later make up for the lost time.

IMPORTANCE OF PHONETIC METHOD OF INSTRUCTION—*a.* The phonetic method of instruction (entirely by sound) is used. This speeds up the mental process of learning and recognizing characters. If you do not use the sound method you will go through a double deciphering process, first to hear the signal, then to determine its "dot-dash" makeup. Learning by sound eliminates the second step. You recognize each signal instantly as the character it represents. This is essentially a new language you are learning to recognize and talk. Soon you will be able to read it, write it, and communicate your ideas to others.

b. At first, aim to get each letter on paper just as soon as possible after hearing it. Immediately upon recognizing the character, stop thinking of it as a sound; think of it then only as a letter or numeral to print or type. This leaves the mind free to grasp the next sound while you are printing or typing the previous character.

c. At all times think of each character as a sound. Example: dit dah (a); dah dit dit dit (b), etc. Do not count the number of dots and dashes to determine the character. Think only of the sound. The elementary work of learning to recognize each character by its actual sound is one of the most important phases of the code reception course.



Wire-wound vitreous-enameled fixed resistors.

d. The faster you can print or type (as the case may be) the easier it will be for you to copy code. When the mind does not have to struggle with the problem of typing or printing, in addition to code, full concentration on code is possible. It is urged, therefore, that you make every effort to increase your ability to print or type.

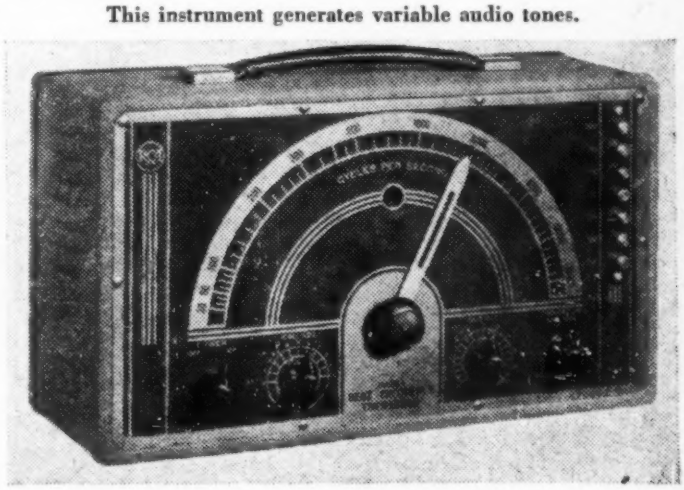
e. When copying, if you miss a character, don't worry about it—go on to the next. Just as soon as the first sound of the next character is heard, stop trying to figure out what the missing character was. During periods of practice the aim should be to get down everything possible without worrying about missed characters. As your ability to copy increases you will miss fewer characters. The more alert you are, the faster you can get characters on paper after hearing them, and you will miss fewer, because you will have more time to think of the next signal.

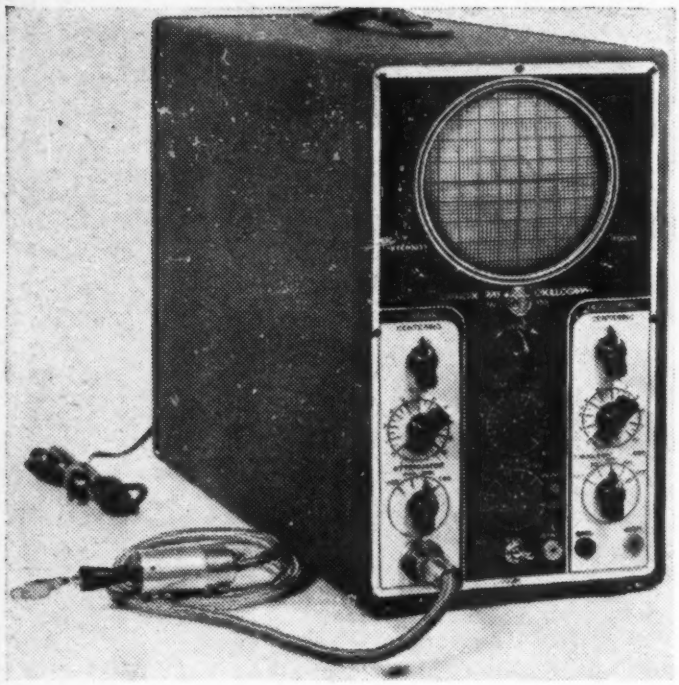
COPYING BEHIND—The real answer to the ability to copy code at high speeds is development of the knack of "copying behind." Contrasted with "copying ahead," *where you anticipate what is coming, a faulty, dangerous practice,* the ability to copy "behind" should be cultivated as soon as possible. AFTER YOU HAVE THOROUGHLY MASTERED THE CODE, you should start by trying to carry two characters in your head before you record either on paper. As soon as you recognize the second character, put the *first* on paper, and so on. By constant practice you will find yourself able to carry several characters in your head at a time, and, in the case of plain language, you will carry whole words. When copying plain language, you must be extra careful not to anticipate what is coming by following the sense of what you are copying. It is correct to read what you are copying (in the case of plain language), but you must not copy "ahead."

LEARNING THE INTERNATIONAL MORSE CODE

In the Signal Corps system of teaching International Morse code, recognition of each letter is combined with instruction in lettering by hand and in touch typing. Thus, for example, the operator is taught that the sound of "dit

This instrument generates variable audio tones.





The oscilloscope gives visual circuit performance.

dit dah dit" means *F* for FOX and should be struck on the typewriter with the first finger of the left hand. The following is a list of the characters, with their corresponding International Morse code sounds and their phonetic equivalents in the approximate order in which they are taught in successive lessons.

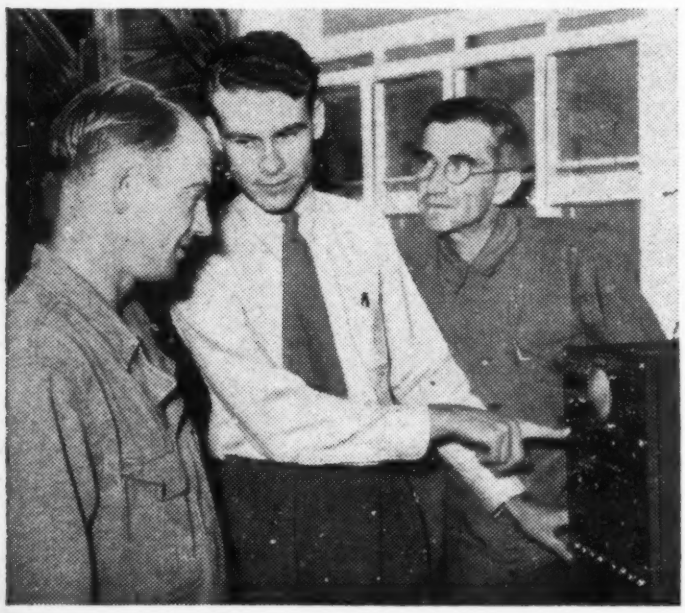
RECEIVING LESSON NO. 1

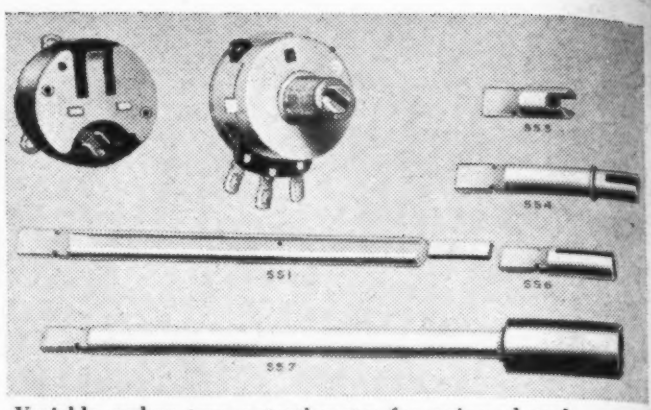
Character	*Sound*
F	Dit dit dah dit
H	Dit dit dit dit
G	Dah dah dit
M	Dah dah
J	Dit dah dah dah
R	Dit dah dit
U	Dit dit dah

RECEIVING LESSON NO. 2

Character	*Sound*
B	Dah dit dit dit
D	Dah dit dit

Instructor explains pattern on oscilloscope screen to student.





Variable carbon type potentiometer for universal replacements.

K	Dah dit dah
N	Dah dit
T	Dah
V	Dit dit dit dah
Y	Dah dit dah dah

RECEIVING LESSON NO. 3

Character	*Sound*
C	Dah dit dah dit
E	Dit
I	Dit dit
L	Dit dah dit dit
O	Dah dah dah
S	Dit dit dit
W	Dit dah dah

RECEIVING LESSON NO. 4

Character	*Sound*
A	Dit dah
P	Dit dah dah dit
Q	Dah dah dit dah
X	Dah dit dit dah
Z	Dah dah dit dit
4	Dit dit dit dit dah
5	Dit dit dit dit dit

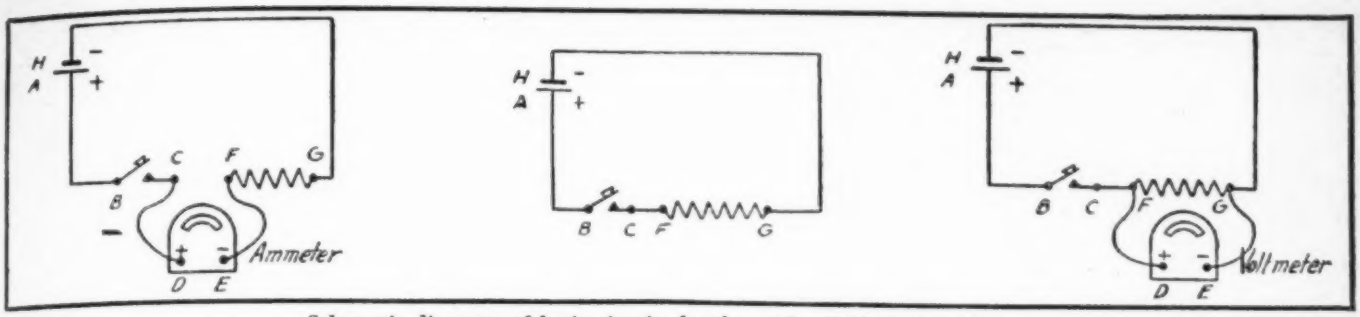
RECEIVING LESSON No. 5

Character	*Sound*
1	Dit dah dah dah dah
2	Dit dit dah dah dah
3	Dit dit dit dah dah
6	Dah dit dit dit dit
7	Dah dah dit dit dit
8	Dah dah dah dit dit
9	Dah dah dah dah dit
0	Dah dah dah dah dah

TRANSMITTING THE INTERNATIONAL MORSE CODE

GENERAL—The ability of a radio operator to transmit well-formed and well-spaced code characters is just as important as his ability to recognize and record them accurately. Thus, it is essential that the student adhere to prescribed methods when practicing, because habits which are formed in the initial stages of learning will remain throughout his career. A bad habit can limit an operator's speed to such an extent that he will be incapable of reaching his true peak. To this end, it is necessary that instructors give personal instruction to, and exercise close supervision over, all students while they are learning to transmit.

TRANSMITTING PRACTICE AND EXERCISES—Before actually attempting the formation of characters certain exercises can be given which will develop the student's sense of spacing, rhythm, and properly balanced formation of "dits" and "dahs." One of the best exercises is the sending of "dits" at a rate of about 200 per minute or "dahs" at a rate of about 70 per minute. For later exercises, formation of characters combining "dits" and "dahs," where the principle of rhythmic balance is carried through, should be included. (V, B, C, P, R, and X are particularly good as an illustration of this.) Whenever wrist and forearm muscles begin to tire of making one character or there is a



Schematic diagrams of basic circuits for the study of Ohm's Law theory.

break in rhythm, switch to another character. Prolonged sending practice is necessary to develop the muscles for true rhythmic sending, but the beginners will need frequent rests. Stretching the open fingers, flexing the wrist, or pressing fingertips against table edge until the back of the hand is bowed are good methods of relaxing.

COURSE FOR RADIO MECHANICS (ENLISTED)

The radio mechanics trained by the Signal Corps form an indispensable link in the chain of our world-wide Army communications. These radio mechanics, in addition to demonstrating mechanical aptitude and becoming adept in the use of all the tools needed in radio repair, must also learn the theory of direct and alternating current circuits and the functioning of radio tubes and their associated circuits.

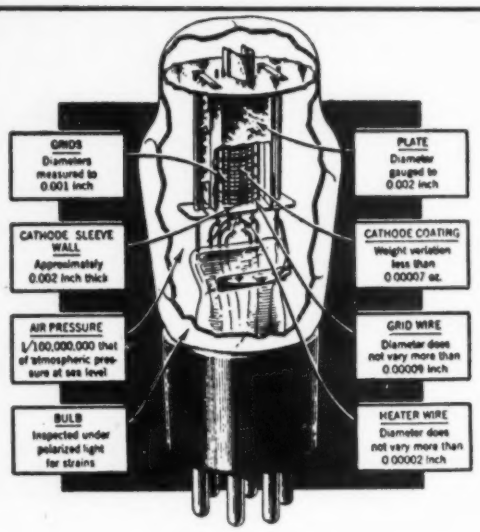
The following outline is the course which has been prescribed by the Chief Signal Officer for civilian radio schools to which enlisted men of the Signal Corps are assigned in large numbers for their technical training. The duration of the course is 13 weeks. Upon its completion the enlisted radio mechanic, who previously took his basic military training at camp, returns to one of the Signal Corps centers for a final period of training in repair and maintenance of a specific group of Signal Corps radio sets in which he becomes an expert.

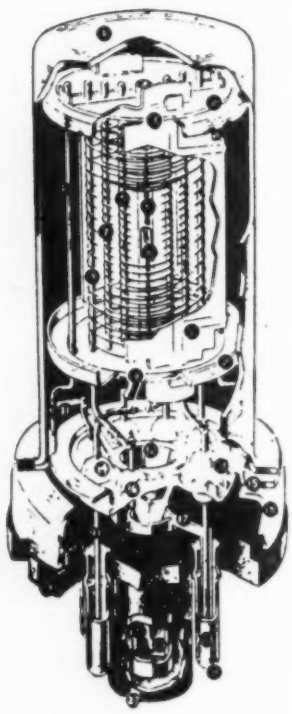
The course outlined below is similar to those taken by the larger number of Signal Corps radio mechanics who are not detailed to civilian schools and who obtain their entire training, from the basic school of the soldier to the theory and operation of radio sets, at one of the Signal Corps training camps.

SIGNAL CORPS
OUTLINE OF COURSE FOR RADIO MECHANICS

1. Review of Mathematics.
   - *a.* Common and decimal fractions.
   - *b.* Exponents, squares and roots.
   - *c.* Angles and angular measurements.
2. Shop Work.
   - *a.* Classification, care and maintenance of tools.
   - *b.* Splicing wires.
   - *c.* Measuring and gauging.
   - *d.* Wood working, metal working and soldering.
   - *e.* Wiring of radio equipment.
3. General Electrical Theory.
   - *a.* Direct current circuits.
     - (1) Electron theory. Conductors and insulators.
     - (2) Resistance, voltage and current. Ohm's Law.
     - (3) Series and parallel circuits.
     - (4) Primary and storage cells. Battery connections.
     - (5) Magnetism and electromagnetism. Fields and flux.
     - (6) Induced electromotive force, inductance and capacitance.
     - (7) D-C meters.
     - (8) Power and work. Heating effect.
     - (9) Generators, motors and control equipment.
     - (10) Fuses and protective devices.
   - *b.* Alternating current circuits.
     - (1) Fundamental a-c theory. Wave forms. Frequency.
     - (2) Generation. Phase, effective value.
     - (3) Inductance and impedance.
     - (4) Resistance and capacity. Reactance.
     - (5) Resonant circuits.
     - (6) Transformers.
     - (7) Generators, rectifiers and converters.
     - (8) Induction, synchronous and repulsion motors.
     - (9) A-C meters.
4. Radio Theory.
   - *a.* Fundamentals.
     - (1) Radiation and reception of electrical energy.
     - (2) Types of radio waves. Wave propagation.
     - (3) Wave length and frequencies. Availability of frequency bands.
     - (4) Circuit elements and symbols.
     - (5) Series and parallel resonance.
     - (6) Frequency meters.
     - (7) Coupling. Tuned circuits.
   - *b.* Electronics.
     - (1) Fundamentals of vacuum tubes.
       - (a) Electronic emission.
       - (b) Tube types.
       - (c) Construction of different types.
     - (2) Characteristics of vacuum tubes.
       - (a) Static characteristics
       - (b) Amplification factors.
       - (c) Characteristic curves and diodes, triodes, tetrodes, pentrodes and other multi-electrode tubes.
       - (d) Vacuum and gas filled tubes.
       - (e) Applications of different tubes. Amplifiers and rectifiers.
     - (3) Amplification.
       - (a) Resistance-, impedance- and transformer-coupling.
       - (b) Voltage and power amplification.
       - (c) Audio and radio frequency amplification.
       - (d) Classes A, B and C amplifiers.
       - (e) Distortion and noise.
       - (f) Power amplification.
       - (g) Multi-stage amplification.

Tube and set testers give students an opportunity to analyze circuits.


GRIDS
Diameters measured to 0.001 inch
PLATE
Diameter gauged to 0.002 inch
CATHODE SLEEVE WALL
Approximately 0.002 inch thick
CATHODE COATING
Weight variation less than 0.00007 oz.
AIR PRESSURE
1/100,000,000 that of atmospheric pressure at sea level
GRID WIRE
Diameter does not vary more than 0.00009 inch
BULB
Inspected under polarized light for strains
HEATER WIRE
Diameter does not vary more than 0.00002 inch



1 — METAL ENVELOPE	10 — PLATE	19 — LEAD WIRE
2 — SPACER SHIELD	11 — BATALUM GETTER	20 — CRIMPED LOCK
3 — INSULATING SPACER	12 — CONICAL STEM SHIELD	21 — OCTAL BASE
4 — MOUNT SUPPORT	13 — HEADER	22 — EXHAUST TUBE
5 — CONTROL GRID	14 — GLASS SEAL	23 — BASE PIN
6 — COATED CATHODE	15 — HEADER INSERT	24 — EXHAUST TIP
7 — SCREEN	16 — GLASS-BUTTON STEM SEAL	25 — ALIGNING KEY
8 — HEATER	17 — CYLINDRICAL BASE SHIELD	26 — SOLDER
9 — SUPPRESSOR	18 — HEADER SKIRT	27 — ALIGNING PLUG

Skeleton view of glass (top) and metal (bottom) receiving tubes.

(h) Beam-tube and push-pull amplifiers.
(4) Power supplies.
(5) Cathode ray oscilloscope.

c. Radio circuits.
(1) Detection.
(a) Types of detectors.
(b) Vacuum tube voltmeters.
(2) Oscillators.
(a) Fundamental theory.
(b) Types of oscillators.
(c) Crystal oscillators. Frequency multiplication.
(3) Modulation.
(a) General considerations.
(b) Amplitude modulation.
(c) Frequency modulation.
(d) Demodulation.
(4) Transmitters.
(a) Transmission of energy.
(b) Modulated Output Power Amplifiers.
(c) Neutralization.
(d) Frequency multiplication.
(e) Interstage coupling.
(f) Radio-frequency transmission lines.
(5) Receivers.
(a) Heterodyne, regenerative, autodyne and super-regenerative detection.
(b) Tuned-radio frequency receivers.
(c) Superheterodyne receivers.
(d) Interference. Shielding.
(6) Power supplies.
(a) A-C operated power supplies.
(b) Vibrator power supplies.
(c) Voltage regulators.
(7) Antenna systems.
(a) Classes of antennas.
(b) Feeding antennas.
(c) Directivity.
(d) Design considerations.

5. Radio Testing and Repair.

a. Measuring and testing instruments.
(1) Voltmeters, ammeters and ohmmeters.
(2) Tube checkers.
(3) Selective analyzers.
(4) Output meters.
(5) Frequency meters.
(6) Signal generators.
(7) Cathode-ray oscilloscopes.

b. Trouble analysis and location.
(1) Recognition of trouble indications.
(2) Use of testing instruments.
(3) Analysis and interpretation of measurement results.

c. Repair of radio sets.
(1) Care of tubes and other components.
(2) Replacement of defective parts.
(3) Handling of tools.
(4) Commercial sets.
(5) Repair of Signal Corps field equipment.
(a) Receivers.
(b) Transmitters.
(c) Power units.
(d) Combined units. "Walkie-Talkie" sets.

d. Field practice with Signal Corps equipment.

CIVILIAN TRAINING COURSES

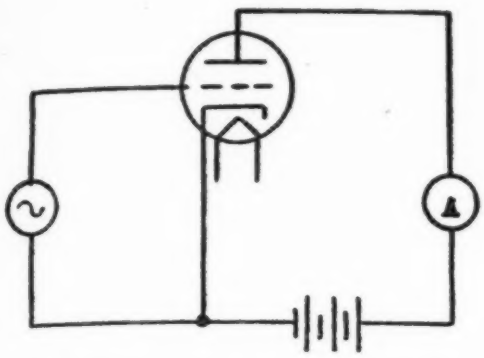
The pre-service Civilian Training program is designed to develop a large number of trained radio mechanics and technicians for the Signal Corps. These courses are on different levels so that elementary training is provided for civilians with no previous radio experience or training, while more advanced courses are provided for those who either have completed the elementary course or who enroll with a more complete experience background.

Those who have had no experience or training in radio repair may enter full-time training courses as Mechanic Learner (Radio). Mechanic Learner employees of the Signal Corps are hired by the Civil Service Commission at a salary of $1,020 a year. The requirements for admission to this course take the form of tests which demonstrate learning ability and manual dexterity.

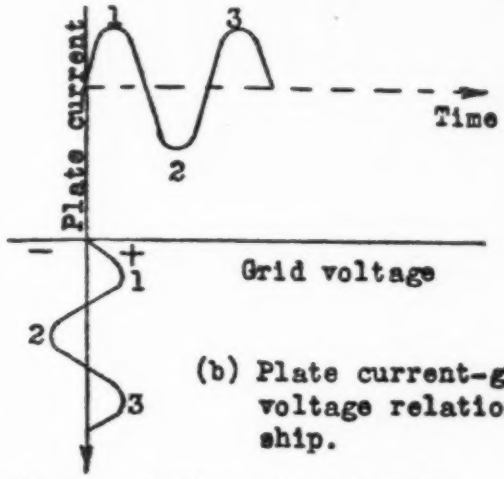
Those who successfully complete the "Mechanic Learner" course may join others who come in with a higher level of previous experience, in the category of Junior Repairman Trainee (Radio), at a salary of $1,440 a year. Those who have not previously completed the "Mechanic Learner" course must show background of recent training or experience in radio in civilian life.

These courses are given on a full-time basis in vocational schools and other institutions throughout the country. The student can usually obtain the training at a point not very far from his home.

Preference is given in the choice of trainees to men of military age who can pass the physical requirements for the Enlisted Reserve of the Army. These men are retained in

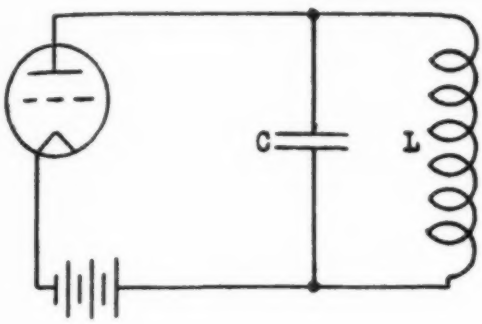


(a) Fundamental triode circuit.

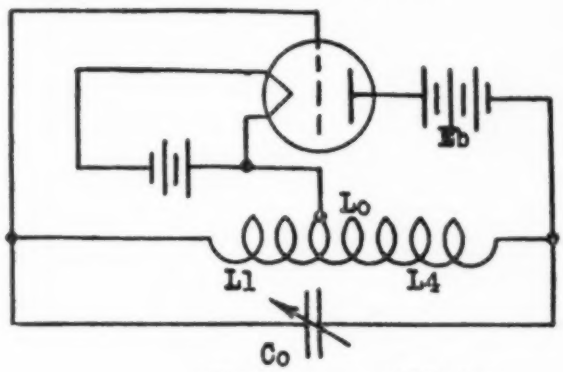


(b) Plate current-grid voltage relationship.

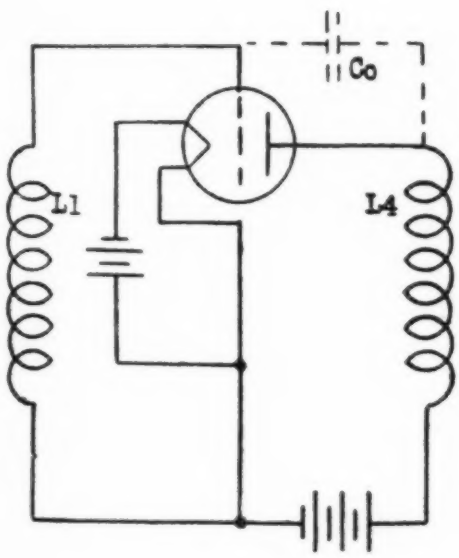
Plate current-grid voltage relations in a triode.



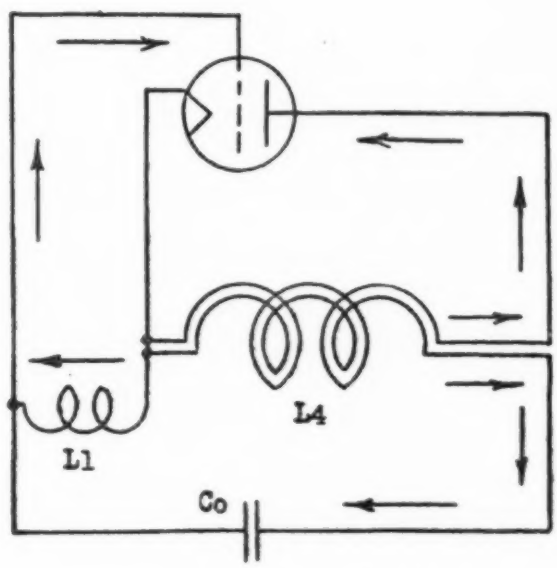
Triode with resonant circuit as plate load.



Hartley oscillator circuit.

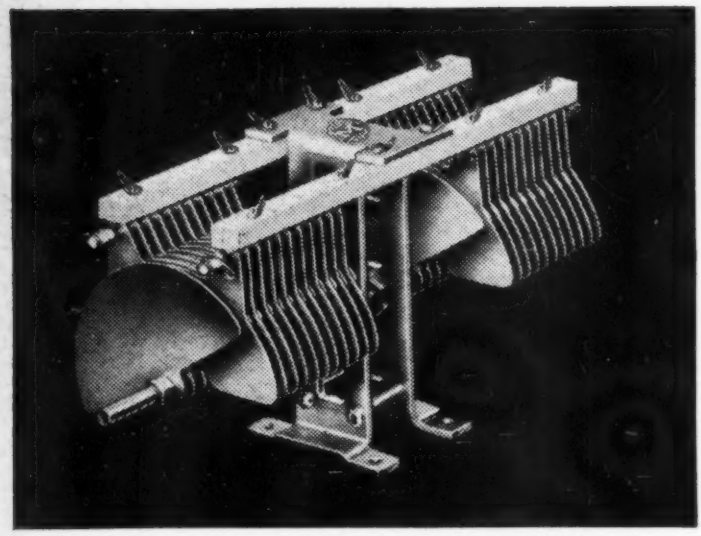


Hartley oscillator without mutual inductance.



Current relations in Hartley oscillator without mutual inductance.

You will study many oscillator circuits. Several are shown in this schematic diagram.



Balanced two-gang variable transmitting condenser.

Three types of electrolytic filter condensers.

the Enlisted Reserve Corps if their training proceeds satisfactorily until they complete their courses or until an immediate need for their services arises, at which time they are called to active duty in the Signal Corps. This program makes it possible for those with an aptitude and inclination toward radio work to be assured that they will serve in that specialized field when called up by the Army.

A selected group of trainees who complete the course for Junior Repairman Trainees (Radio) and demonstrate ability for more advanced radio work may be continued in training, with an increase in pay, to learn highly advanced circuits and techniques utilized by the Signal Corps.

To the extent that vacancies remain beyond those required for the training of men in the Enlisted Reserve Corps, the same training may be obtained by women and men not available for military service. For them these training courses lead to Civil Service positions in the numerous shops, depots, laboratories and other domestic activities of the Signal Corps in connection with its research, engineering, development, installation, maintenance and procurement functions in the Services of Supply.

The following pages contain the outlines for the two basic Civilian Training courses in radio sponsored by the Signal Corps—Mechanic Learner (Radio) and Junior Repairman Trainee (Radio).

In addition to those two courses, there are others of a specialized nature offered by the Signal Corps to applicants who demonstrate aptitude for advanced radio work.

MECHANIC LEARNER (RADIO)

This course is designed for Mechanic Learners, selected from the registers of the United States Civil Service Commission, to be given training which will lead to the position of Junior Repairman Trainee (Radio) at $1,440 per year. It includes the use of the essential tools; the basic shop or laboratory activities; the ability to read simple plans and symbols.

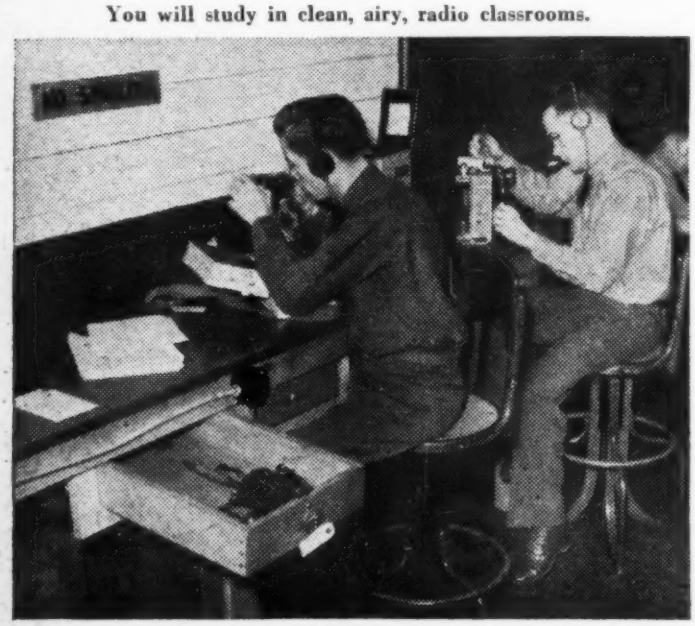
INSTRUCTIONAL OUTLINE

1. Trainees will learn to identify, care for and use as directed, the tools and simple equipment necessary for this position.

A. Tools.

1. Brace (carpenter's ratchet).
2. Calipers (micrometer, outside, inside and vernier).
3. Clamps (C clamps, others).
4. Countersinks (metal and wood).
5. Cutters (adjustable circle).
6. Die stocks.
7. Dividers.
8. Drills (hand, breast, portable electric, bench).
9. Drivers (nut, screw offset and straight).
10. Gages (thread, wire, drill, feeler).
11. Hammers (machinist, ball pien, riveting, etc.).
12. Hacksaw.
13. Knife.
14. Nippers.
15. Pliers (diagonal cutting, long-nose, combination slip

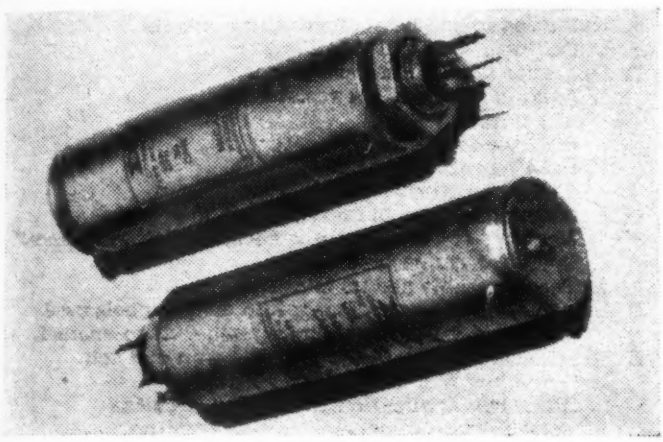
You will study in clean, airy, radio classrooms.



You'll learn the difference between saw cuts.

joint, parallel jaw, electrician's).
16. Punches (center, etc.).
17. Reamers.
18. Rules.
19. Saws.
20. Scissors (electrician's).
21. Shins.
22. Snips.
23. Soldering irons.
24. Square (combination with center head and protractor).
25. Torches (alcohol).
26. Tweezers.
27. Vises (machinist's—with and without swivel racks).
28. Wrenches (adjustable angle, open and adjustable tap).

B. Equipment.
1. Batteries.
2. Head phones.
3. Microphones.
4. Miscellaneous wire, cords, drops and working material as required.
5. Output indicators.
6. Simple condensers and coils.
7. Simple meters—voltmeter, ammeter, wattmeter, ohmmeter, tachometer.
8. Switches and keys.
9. Simple receivers as approved.
10. Speakers.



Wet type electrolytic condensers—used in receivers.

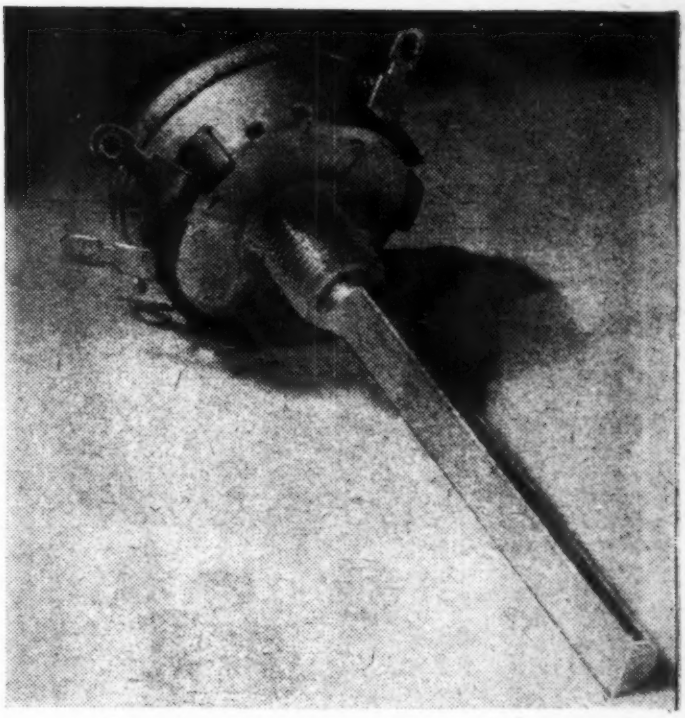
SCHOOL SHOP OR LABORATORY OUTLINE

Topic I—Soldering and Splicing.
A. Tinning the iron.
B. Stripping single conductor wire.
C. Solder pieces of wire to a tin plate, lugs, terminal strips, phone tips, male and female plugs.
D. Serving cords and cables.
E. Stripping, sheathing from cables.
F. Assemble cords used by Signal Corps.

Topic II—Salvaging.
A. Remove individual components from chassis.
1. Make sketch or connections prior to removal.
2. Make simple continuity tests.
3. Re-install removed part.
4. Clean up and make ready for future use parts not to be installed in chassis from which they were removed.

Topic III—Drilling, Tapping and Simple Layout.
A. Sort hardware, such as screws, etc., according to type, size, etc.
B. Use proper tools for simple layout.
C. Drill and tap holes in assorted metals and composition materials.
D. Layout and make simple chassis to mount salvaged parts from jobs done under Topic II (and used to make an oscillator or similar simple circuit, according to instructor's directions).

Topic IV—Assembling.
A. Assemble jobs outlined in section D of Topic III.
B. Tear down and assemble a small receiver or transmitter or integral section thereof.
C. Make simple continuity tests to check wiring of reassembled jobs.



Center-tapped volume control (potentiometer).

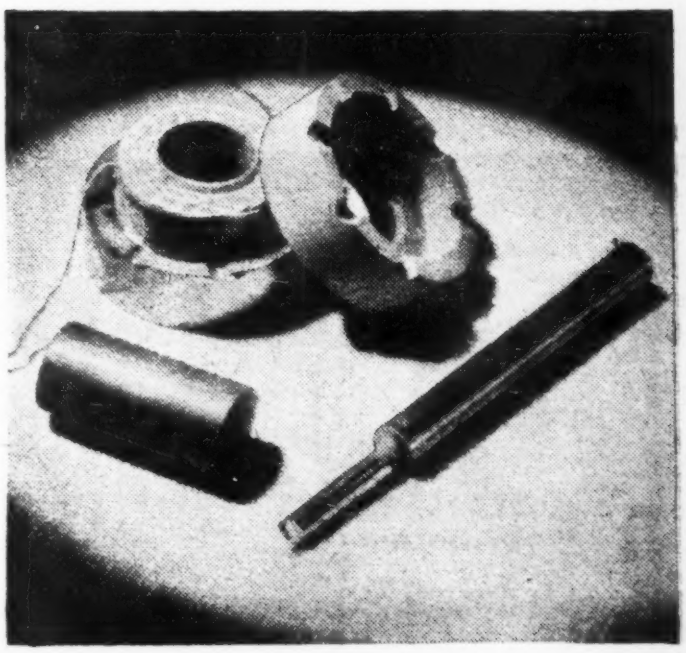
Topic V—Wind and Repair Single-Layer Coils.
A. Strip coils.
B. Rewind coils.
C. Use wire gage and micrometer in choosing proper wire for winding.

Topic VI—Simple Testing.
A. Use the voltmeter and ohmmeter.
B. Use the tube checker.
C. Use the condenser and inductance bridge in measuring L. and C.

OUTLINE OF THEORY OF RADIO

Topic I—Electron Theory.
Elementary Principles.
A. Structure of matter.
1. Compounds and elements.

Iron cores and honeycomb coils—used in rf transformers.

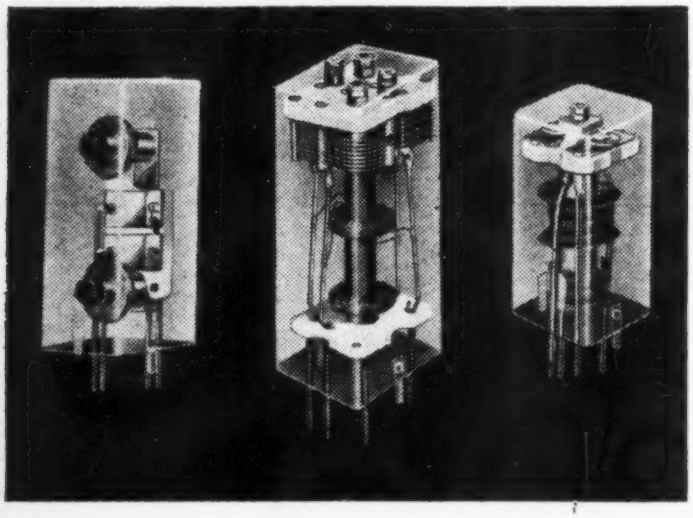


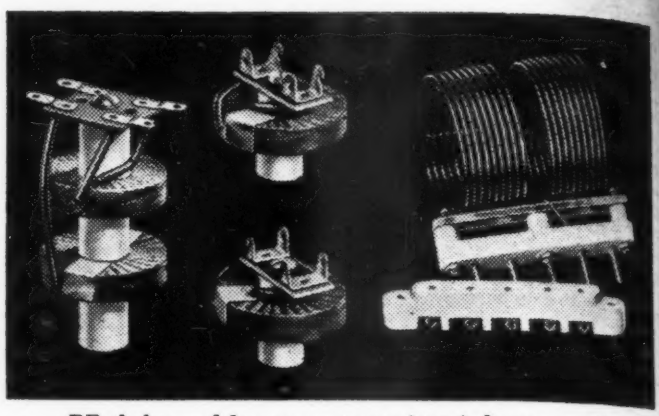
The vacuum tube voltmeter is used on critical circuits.

2. Molecules and atoms.
3. Similarity of structure of all atoms.
4. Matter mostly empty space.
5. Protons—positive charges.
6. Electrons—negative charges.

B. Electric current.
1. Laws of attraction and repulsion between electrons and protons.
2. Electron motion.
   a. "Bumping" or "drift."
   b. Contrast direction of electron and current flow.
3. Sources of electric current.
   a. Batteries.
   b. Generators.

Three types of intermediate frequency transformers—for super hets.





RF chokes and low-power transmitter inductance coil.

   c. Thermocouples.
   d. Photo electric tubes.
   e. Friction.
4. Conductors and insulators.
   a. Difference.
   b. Examples.
5. Classification of conductors and insulators.
   a. Dielectric strength of insulators (basic principles).

Topic II—Fundamental Electrical Units.

A. Definition of ampere, coulomb, and current.
B. Definition of volt and E.M.F.
C. Definition of ohm and resistance.
1. Factors which affect resistance.
   a. Length.
   b. Cross-sectional area.
   c. Different materials.
   d. Temperature.
2. Meaning of "specific resistivity."
3. Meaning of "temperature coefficient of resistance."
4. The wire gauge and its use.
5. The wire table and its use.

D. Prefixes—milli, micro, meg, kilo, and symbols used.
1. Simple problems in changing one unit to another.

E. Relationship between the ampere, ohm and volt.
1. Ohms law formula—($E = I \times R$).
2. Ohms law application to a series circuits.
   a. Definition of open and closed circuits.
   b. Definition of series circuit.
3. Current distribution in a series circuit.
4. Voltage drop and current flow through a resistance.
5. Voltage drops across parts of circuit.
6. Calculation of resistance of parts of circuit.
7. Total resistance of a series circuit (formula).
8. Ohms law application to a parallel circuit.
   a. Definition of parallel circuit.
   b. Current through parallel resistors and total current.
   c. Voltage drops across parallel resistors.
   d. Total resistance.
   e. Effect of changing value of one resistor on the current and voltage drops.
   f. Meaning of term "Mho."

F. Definition of "Power" and "Watt."
1. Relationship between energy, power, and work.
   a. Energy forms—light, heat, electricity, etc.
2. Formula for power—$W = I^2R$ and $W = E \times I$.
3. Wattage dissipation of resistors (simple problems).

Topic III—Magnetism.

A. Laws of attraction and repulsion between magnets.
1. Like and unlike poles (name of poles).
2. Force and attraction of repulsion (formula—no problems).

B. Typical magnetic substances.
C. Examples of non-magnetic substances.
D. Meaning of the following terms:
   a. Lines of force.
   b. Magnetic field.
   c. Magnetic flux.
   d. Magnetic density.

1. Antenna

2. Antenna, Loop

3. Ammeter

4. Battery (Positive terminal indicated by long line).

5. Capacitor, (Condenser) Fixed

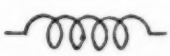
6. Capacitor, (Condenser) Variable

7. Capacitor, (Condenser) Variable (Rotor plates indicated by curved arrow)

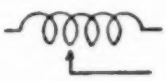
8. Counterpoise

9. Ground

10. Inductor, Air Core

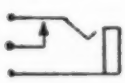


11. Inductor, Adjustable



12. Inductor, Variable

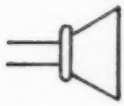
13. Jack



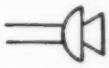
14. Key

15. Lightning Arrestor

16. Loud Speaker

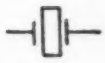


17. Microphone



18. Phototube

19. Piezo-electric Plate (Crystal)



20. Rectifier Tube, Full wave (With cold cathode)

21. Rectifier Tube, Half wave (With cold cathode)

22. Resistor, Fixed

23. Resistor, Adjustable (Rheostat)

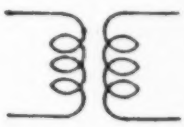
24. Resistor, Tapped

25. Resistor, Variable

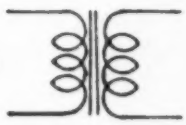
26. Headphones

27. Thermoelement

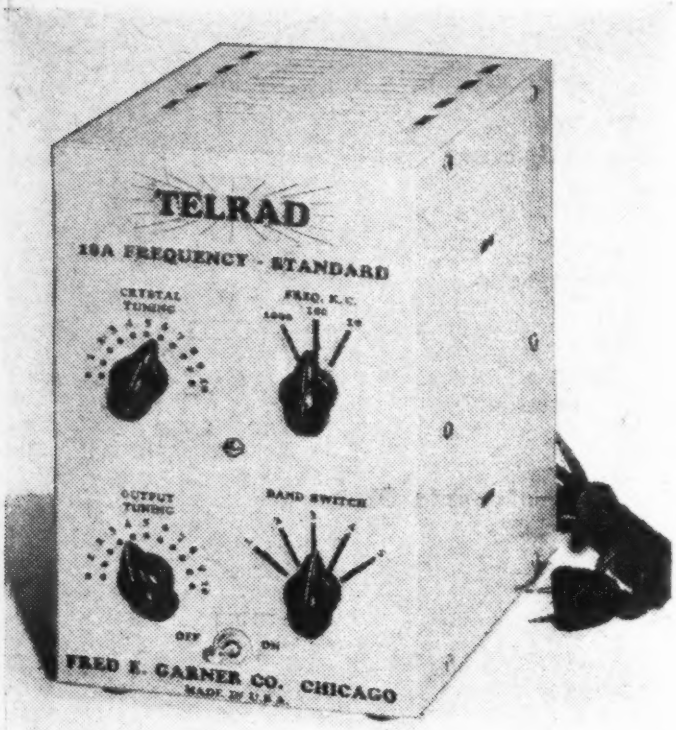
28. Transformer, Air Core



29. Transformer, Iron Core



Most-used radio parts symbols employed throughout all schematic radio wiring diagrams.



Students learn to set frequency of transmitters with a Standard.

e. Temporary magnet.
f. Permanent magnet.

Topic IV—Electromagnetism and Electromagnetic Induction.
A. Magnetic field around a straight wire which carries a current.
B. Right hand rule for wires.
C. Magnetic field around a coil.
D. Right hand rule for coils (solenoids).
E. Effect of the number of turns on a coil.
F. Relationship between electron flow and magnetic field.
G. Meaning and application of "magnetomotive force" and "ampere turns."
H. Construction features of electromagnets.
I. Meaning of "permeability" and "reluctance."
1. Comparison of "conductivity" and "resistance."
2. General comparison of the electric circuit to the magnetic circuit.
J. Meaning and cause of "magnetic saturation."
K. Meaning of hysteresis.
L. Induction of a current by a moving magnet and stationary wire, or coil, and vice versa.
M. Explanation of induced E.M.F.
N. Direction of induced E.M.F. and Lenz law.
O. Meaning of "alternating current" (A.C.).
P. Simple explanation of operation of A.C. generator.

Topic V—Inductance, Inductors, Transformers.
A. Meaning of "self inductance."
B. The unit of inductance.
C. Non-inductive coils.
D. Inductors in series and parallel (formulas and simple calculations).
E. Mutual induction.
F. Coupling, effects of loose and close coupling.
G. Coefficient of coupling.
H. Coupling between wires.
1. Line transposition.
2. Lead dress.
3. Shielding.
I. Mutual inductance (the transformer).
J. Construction features of practical transformers.
K. Transformer windings and calculations (formulas).
1. Turns ratio and voltage distribution.
2. Single and multi-secondary windings.
L. Transformer losses—meaning of Eddy currents, core losses, copper losses.

Topic VI—Capacitance and Condensers.
A. Action of charge and discharge of a condenser.
B. Unit of capacitance, the farad.
C. Factors which affect condenser capacitance.
1. Area of plates.
2. Number of plates.
3. Dielectric.
D. Voltage breakdown (causes).
1. Safe working voltages.
2. Peak voltages.
E. Condenser losses.
1. Resistance.
2. Leakage.
3. Dielectric absorption.
4. Dielectric hysteresis.
F. Condensers in series.
G. Condensers in parallel.
H. Purpose of connection condensers in series and parallel.
I. Construction features of oil, paper, mica, and electrolytic condensers.
J. Construction features of tuning condensers (receiving and transmitting).

Topic VII—Resistor Types.
A. Carbon resistors.
1. Standard sizes and wattage ratings.
2. Color code.
B. Wire wound resistors.
1. Voltage dividers, standard sizes and wattage ratings.
C. Volume controls, rheostats, and other special applications.

Topic VIII—Blueprint Reading.
A. Symbols.
B. The schematic circuit drawing.
C. Wiring or picture diagram.
D. Vacuum tube base pin connections.

Topic IX—Hardware Classification, Taps and Drills.
A. Classification by type (nuts, bolts, screws, etc.).
B. Classification by material and finish (brass, steel, plated brass, etc.).
C. Standard threads.
D. Taps and drills (commonly used).
E. Clearance and body drill sizes.

PRE-SERVICE TRAINING COURSE For JUNIOR REPAIRMAN TRAINEE (RADIO) ($1440 Per Year) UNITED STATES SIGNAL CORPS

General Considerations.

This course is designed for the pre-service training of Junior Repairman Trainee (Radio) for service in the United States Signal Corps. Its general purpose is to prepare men or women to take positions in the field installations of the Signal Corps for overhaul, maintenance, repair, and inspection of miscellaneous Signal Corps equipment.

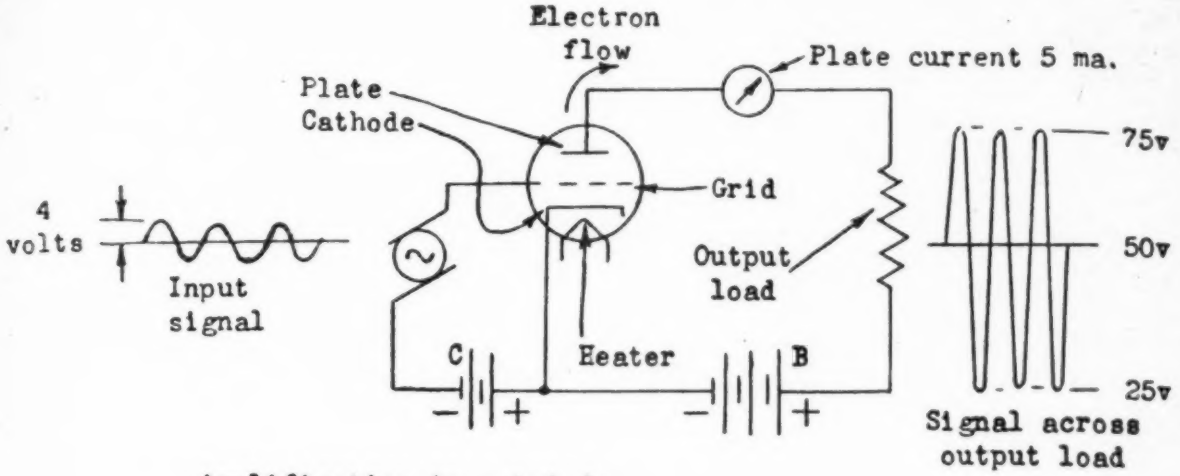
Trainees permitted to take this course will have an unusual opportunity to serve their country in the present crisis along the lines of their interest, ability, and previous training. This service will be an immediate aid to the military forces safeguarding the United States.

The selection requirements of trainees for this course, as set forth in the United States Civil Service announcements, are as follows: In the ten preceding years, the trainee must have completed or acquired one of the following:

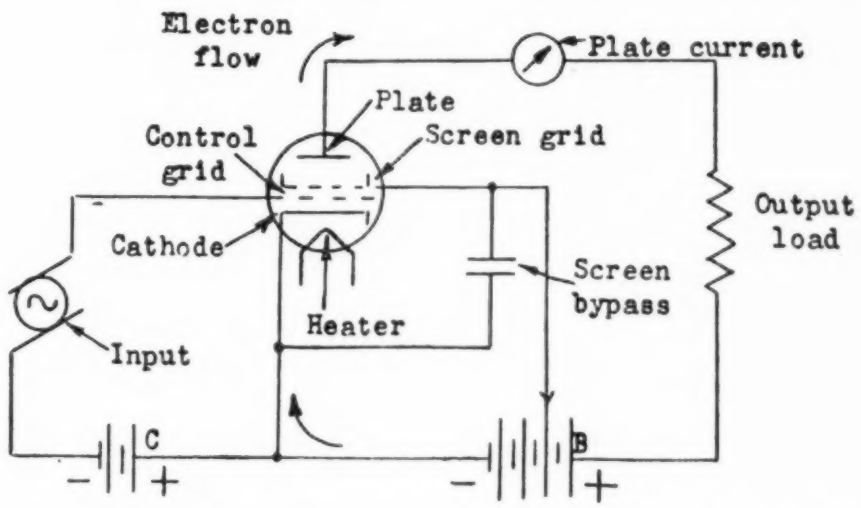
1. A license to operate amateur radio station, if trainee has built sets.
2. Six months of full time paid experience in technical radio work.
3. A two year vocational course in electricity, telephone, or radio repair work.
4. A six month technical course in a radio school.
5. One year's study in a school of engineering.
6. A United States Sponsored Engineering Defense Training Course in telephone or radio work.

Instructional Material.

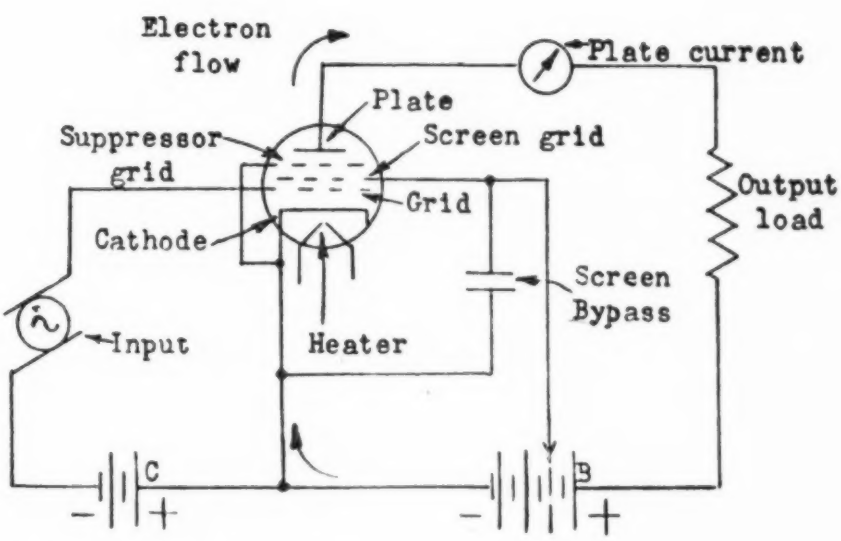
This outline presents the general content of the course for Junior Repairman Trainee (Radio). It emphasizes practical shop and laboratory instruction in which "learning by doing" is stressed. As far as possible, theory, or long ex-



Amplification in a triode.

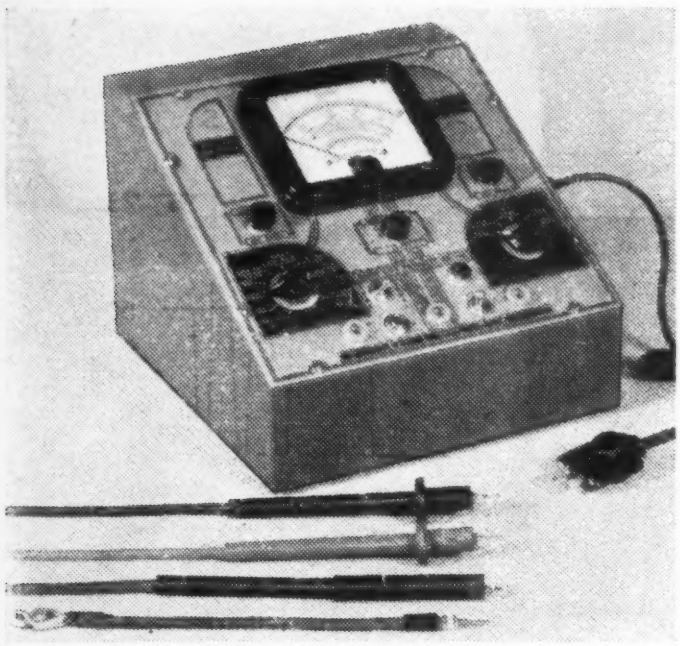


Tetrode amplifier circuit.



Pentode amplifier circuit.

Diagrams are used freely at the Signal Corps Training Centers to clarify important subjects.



Circuits are studied with the aid of versatile test sets.

planation of principles are given in connection with the shop and laboratory activities rather than in extended periods of conventional classroom construction. This does not imply that basic theory is inessential to radio repair work. In the present situation, however, it can best be taught when the practical shop or laboratory situation demands it and not as something apart from it.

OUTLINE
of
SCHOOL SHOP AND LABORATORY WORK

Topic I—Testing parts for operating condition.
Topic II—Construct one tube receiver, power supply, audio amplifier, a six tube superheterodyne receiver from schematic and wiring diagram.
Topic III—Use proper instruments in checking items built under group No. 2 including the signal generator in aligning the superheterodyne receiver.
Topic IV—Construct simple types of signal generators, vacuum tube voltmeter, absorption frequency meter and field strength meter.
Topic V—Build a 5 meter transmitter using crystal controlled Harmonic osc.
Topic VI—Measure precisely by the use of proper bridges, resistance, inductance and capacity.
Topic VII—Analyze construction features of generators, convertors, vibrators and batteries for the purpose of being able to connect them properly to receivers and transmitters.
Topic VIII—Read blueprints and identify parts in receivers and transmitters to which the blueprints correspond.

OUTLINE OF RADIO THEORY

Topic I—The Vacuum Tube.
- A. Sources of electronic emission.
  1. From solids.
  2. From heated objects.
  3. Meaning of the following terms:
     a. Cathode.
     b. Anode.
     c. Filament (heater).
     d. Secondary emission.
     e. Ionization (of gases).
- B. The diode (Fleming valve).
  1. Direction of electron flow.
  2. Direction of current flow.
  3. Effect of plate voltage on plate current.
  4. Effect of filament temperature on plate current.
  5. Saturation (demonstrate with curves).
  6. Diode as a rectifier.
- C. The triode.
  1. Relative position of the control grid.
  2. Grid construction features.
  3. Control action exerted by grid on electron flow.
  4. Grid voltage effects on plate current.
  5. Eg-Ip curves.
- D. The tetrode.
  1. Space charge effects.
  2. Purpose of screen grid.
  3. Construction and relative position of screen grid.
  4. Capacity reducing effect of Screen Grid on the plate grid capacity.
- E. The pentode.
  1. Secondary emission.
  2. Purpose of the suppressor grid.
  3. Comparison of pentode and triode outputs.
- F. Amplification factor.
  1. Meaning of term.
  2. Simple calculation.
  3. Word formula.

Topic II—Detectors.
- A. Purpose of the detector stage.
- B. Crystal detectors.
  1. Detection—rectification.
  2. Types of crystals used.
- C. Vacuum tube detectors.
  1. Meaning of term "grid rectification."
  2. Meaning of term "plate rectification."
  3. Grid-leak-grid-condenser circuit.
  4. Grid bias circuit.
  5. Weak signal versus power detection.
  6. Linear and non-linear detectors.
  7. Diode detectors.
  8. Regenerative detectors.
  9. Distortion (causes of).

Topic III—R. F. Amplifiers.
- A. Purpose of R. F. amplifiers.
- B. Untuned R. F. amplifiers.
  1. Basic circuit.
  2. Advantages and disadvantages.
- C. Tuned R. F. amplifiers.
  1. Triode type.
     a. Fundamental circuit of single and multiple stages.
     b. Need for multiple stages.
     c. Oscillation (control by shielding and neutralization).
  2. Tetrode type.
     a. Fundamental circuits of single and multiple stages.
     b. Advantage over the triode type.
        1. No feed back.
        2. High gain and fewer stages.
- D. Methods of coupling between stages.
  1. Resistance, inductance, and capacity.
  2. Combinations of above and advantages.
  3. Meaning of the following terms—plate, impedance, grid impedance, average values of plate and grid impedance.
  4. Differences between voltage and power amplifiers.
- E. Resonant circuits.
  1. Review, inductance and impedance.
  2. Inductive reactance.
  3. Capacity reactance.
  4. Impedance.
  5. Simple problems on above.
  6. Relationship of X_L, X_C, R in series resonant circuit.
  7. Gain of a tuned circuit.
  8. Resonant curves.
  9. Significance of the following—selectivity, sensitivity and sidebands.
  10. Need for an effect of cutting sidebands.

Topic IV—The Superheterodyne Circuit.
- A. Block diagram.
- B. Comparison to the T. R. F. (tuned radio frequency).
- C. Function of the oscillator.
- D. Purpose of I. F. amplication.
  1. Meaning of I. F.
  2. Advantages of I. F. over R. F. for amplification.
  3. Reasons why I. F. stages are not tuned by ganged variable condensers. (Design and construction.)

E. Types of detector circuits needed:
   1. First detector (mixer or converter).
   2. Second detector (demodulator, of the power type in modern circuits. Often diode type).
F. Importance of proper tuning of I. F. circuits.
   1. Gain.
   2. Sideband cutting.
G. Meaning of "beat frequency" calculations.
H. Meaning of "image frequency."
I. Suppression of image frequency and "repeat points" of a given station.
J. Pre-selection.
   1. Circuits.
   2. Importance.
K. Purpose of bypass condensers.
L. A. C. (60 cycle) voltage distribution:
   1. Filament and heater voltage.
   2. High voltage (transformer plate winding).
M. D. C. voltage distribution.
   1. Potentiometer or voltage—divider principle.
   2. Physical distribution of parts (resisters) underneath the receiver chassis.
N. Methods of wiring, placing lugs, shielding, and general constructional features.

Topic V—Filters.

A. Function of condensers as part of filter circuit.
B. Function of inductances as part of filter circuit.
C. Principle of band-pass filters (high and low).
D. Effect of resistance on controlling filter response.
E. Purpose of tone control, typical applications.
F. Applications and power supply.
   1. Half wave and full wave rectifiers.
   2. Voltage doubling circuits.

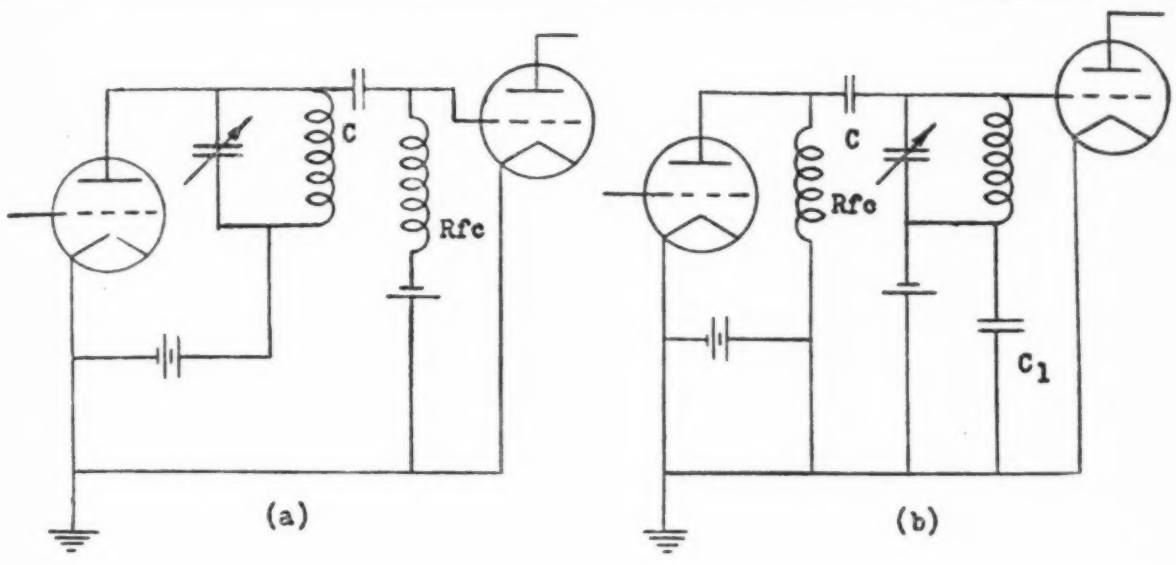
Topic VI—Special Circuits.

A. Automatic volume control circuits.
   1. Separate tube type.
   2. Diodetype.
B. Noise suppression circuits.
C. Automatic frequency control circuits.
D. Band-spread arrangements.

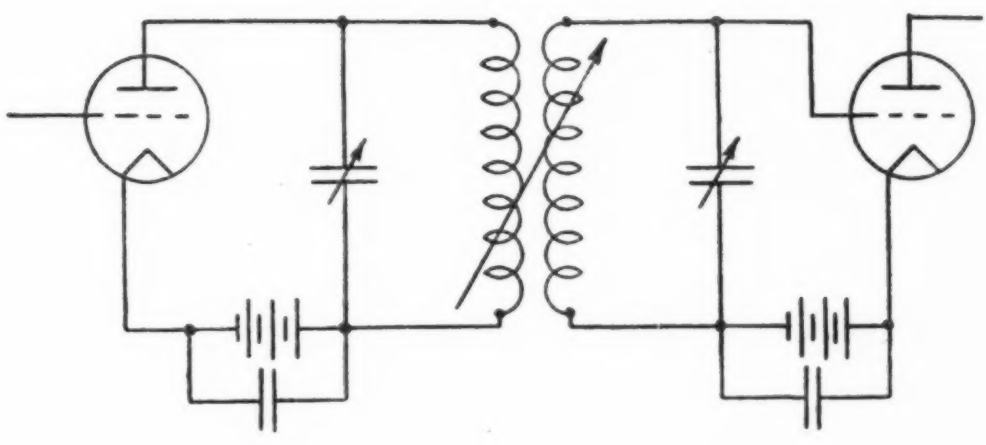
Topic VII—Sound and Sound Production.

A. Sound production and propagation.
B. Comparison of terms, sound, noise, music and speech.
C. Sound frequencies, hearing and the designation normal, good and high fidelity response.
D. Sound pitch, timbre and intensity.
E. The principle of frequency response and mass.
   1. Baffles.
   2. Speakers (trumpets, bass reflex, baffles, other special speaker mountings such as multiple units).
   3. Phones (principle of operation and design).
      a. Types (crystal, etc.).

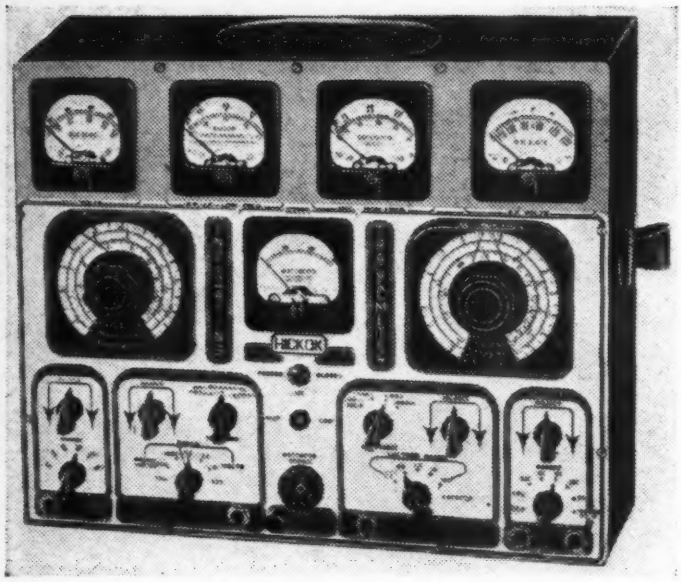
Radio frequency voltages are fed to successive circuits by different means. Below are three examples



Illustrating impedance coupling.



Illustrating inductive coupling.



Hundreds of circuit tests are made with dynamic testers.

4. Speaker types (permanent magnet, electro magnet, etc.).

Topic VIII—Transmitters.

A. Functional comparison between transmitters and receivers.
B. Oscillators.
   1. Crystal control.
      a. Typical circuit (method of operation).
      b. Crystal function and type of cut.
   2. Triode type.
      a. Meaning of terms "self-excited," "oscillate" and "oscillator."
      b. Type variations (Hartley, Colpitts, tuned plate, tuned grid, and electron coupled).
      c. The "tank" circuit (method of tuning, frequency adjustment).
      d. Effects produced by varying plate voltage and off center filament tap.
      e. Problems arising from failure to oscillate, tube overheating.
      f. Key location and effects of keying.
C. Buffer amplifiers.
   1. Purpose of buffer amplifier.
   2. Typical circuits.
   3. Power supply source.
   4. Coupling to other circuits.
   5. Neutralizing (need for).
      a. Procedures used (with neon lamp, thermo-couple ammeter, vacuum tube voltmeter, and oscilloscope).
      b. Checking for proper neutralization.
   6. Tuning procedures.
   7. Keying the circuit.
D. Simple Triode final amplifier.
   1. Purpose.
   2. Typical circuit.
   3. Comparison with buffer amplifier.
   4. Types.
      a. Single output.
      b. Push-pull amplifier (principle of operation, typical circuit, advantages, and disadvantages, neutralization and tuning).
E. Speech amplifiers.
   1. Purpose.
   2. Types (resistance, transformer, and impedance-capacity-resistance coupled).
   3. Microphone input circuits.
      a. Carbon, condenser, velocity, dynamic and crystal types.
      b. Impedance matching.
   4. Pre-amplifier circuits.
      a. Purpose and method operation.
      b. Special problems in shielding, etc.
   5. Amplifier output and R. F. input impedance matching.
   6. Feed back prevention.
   7. Causes and effects of overloading.
   8. Principle of fidelity measurement.
   9. Significance of term "decibel."
   10. Principle of operation of class "A" class "B" amplifiers.
F. Modulators.
   1. Purpose and function.
   2. Position in circuit.
   3. Meaning of terms high level and low level modulation.
   4. System of modulation.
      a. Heising system.
      b. Plate.
      c. Control grid.
      d. Suppressor grid.
   5. Meaning of the terms under modulation, over modulation, upward modulation and downward modulation.
   6. Adjustment for 100% modulation (reasons and simple calculations).
   7. Fidelity testing (method and purpose).
G. Power supplies.
   1. Comparison between receiver and transmitter supplies.
      a. Voltages, power, current.
      b. Safety rules for handling.
      c. Construction features.

Topic IX—Antennas.

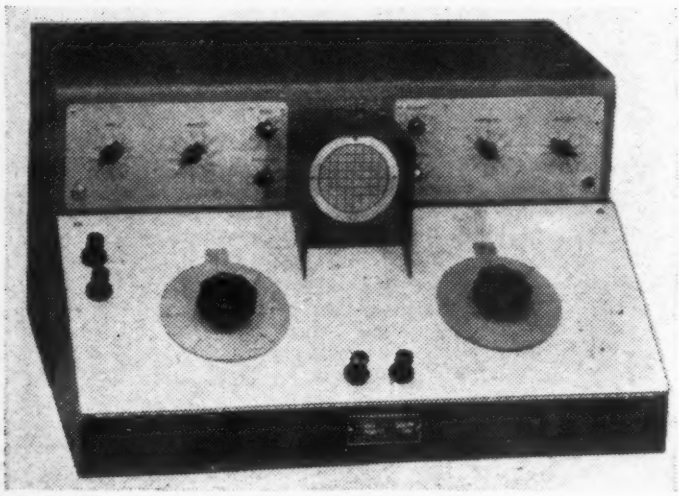
A. Function of receiving and transmitting antennas.
B. Transmitter antenna types.
C. Effective length (simple calculations).
D. Significance of term "coverage" and "field pattern."
E. Functional significance of the radiator and feeder.
F. Coupling methods.
G. Dummy antenna (use, etc.).
H. Power input and output.
   a. Significance of the terms "direct measurement," "indirect measurement," "plate dissipation."
   b. Effect of modulation on power output.

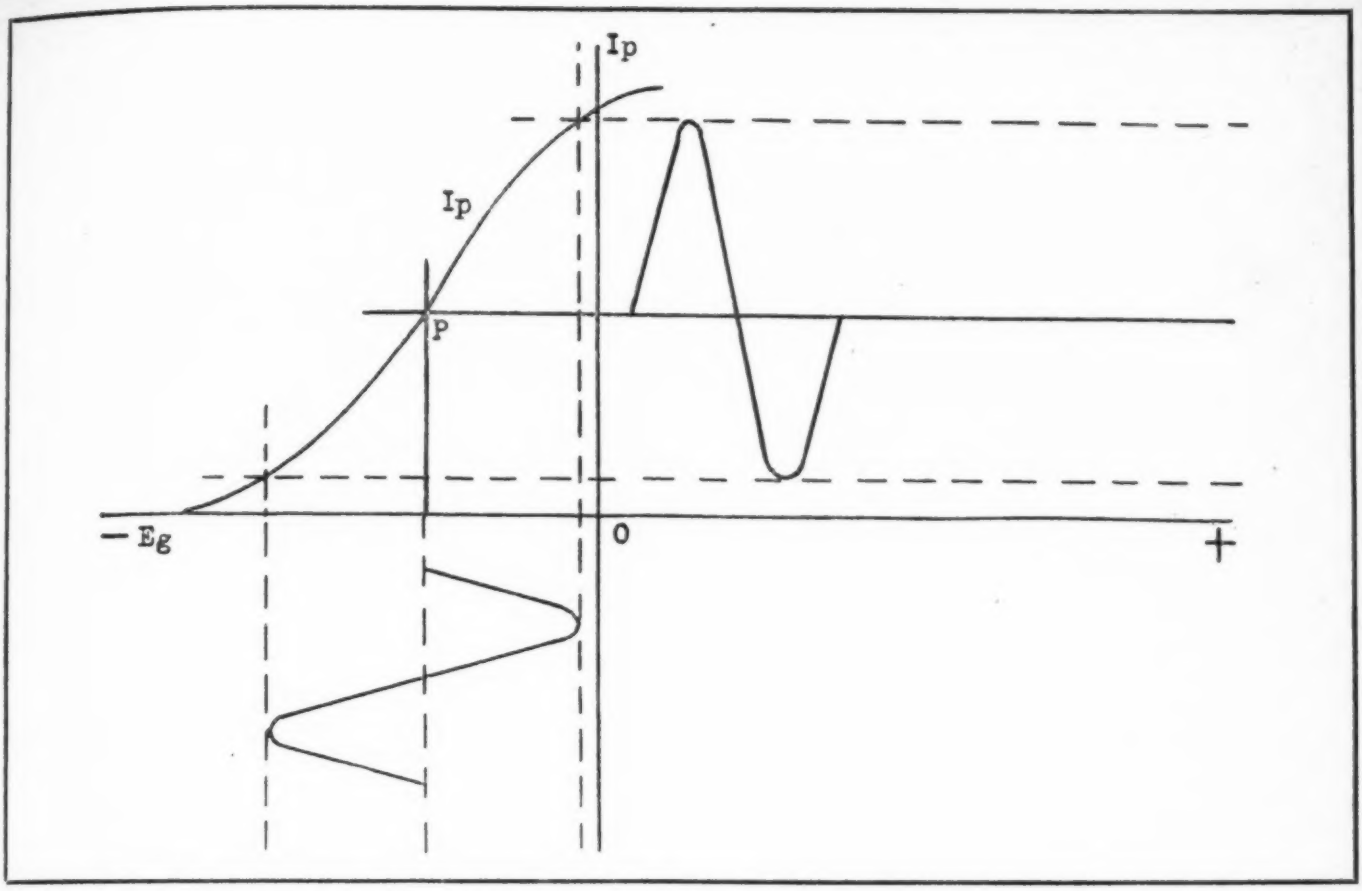
Topic X—Theory of operation, use and construction features of the following test equipment: Multi range voltmeters, ohmmeters, ammeters, milliammeters, power level meters, cathode ray oscillograph, audio, sweep signal and test oscillators, Piezo electric calibrator, neon and other type indicators, the tube checker, the vacuum tube voltmeter, the chanalyst, the A. C. operated bridge Q-meter.

Topic XI—Principles of Physical Inspection of Materials.

A. Use of simple gauges and measuring devices as indicated in tool list.
B. Recognition of various metals and finishes.

Impedance-matching bridge, used in laboratory work.





You, as a student, will learn how to draw and interpret curves. This one shows correct operating range for class A amplifier tube.

INTENSIVE RADIO TECHNICIAN TRAINING COURSE
FUNDAMENTALS OF RADIO

This is a course given at night sessions of colleges and universities in many parts of the country for civilian students. The course is in two parts, each of 16 weeks. The prerequisites for the first part are high school graduation with two years of mathematics and one year of physics. The successful completion of Part I is a prerequisite for entrance into Part II.

The following outline was prepared by Prof. W. L. Everitt of Ohio State University, now on duty as Director of Operational Research in the Office of the Chief Signal Officer. The course was approved by the Chief Signal Officer. Its application in collegiate institutions has been sponsored by the United States Office of Education, which provides the funds that make it possible for the course to be given to selected students without payment of tuition.

INTENSIVE RADIO TECHNICIAN TRAINING COURSE
FUNDAMENTALS OF RADIO—PART I
Night School

16 weeks—total of 144 contact hours plus 96 hours of home study

Study Topic	Recitation Hours	Laboratory Hours	Outside Hours
Mathematics	18	6	18
D. C. circuits	12	9	12
A. C. circuits	34	21	34
Vacuum tube theory	8	6	8
Vacuum tube applications—Part I	12	6	12
Wire telephony and audio systems	12	0	12
	96	48	96

NOTE: 48 "laboratory hours" to be 30 hours of laboratory and 18 hours of supervised study and computation.

Object—To impart basic radio knowledge to laymen. To be followed by Course II.

DETAILED OUTLINE

MATHEMATICS—
Fractions, decimals; elementary algebra and its applications; square roots; right triangles; use of graphs, curves, and tables to give practical and experimental information.

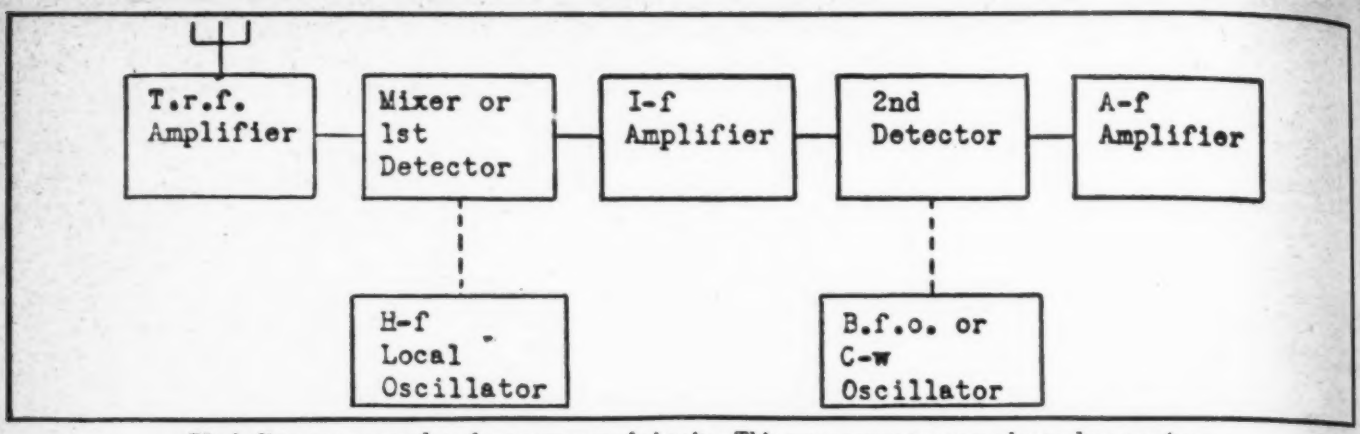
DIRECT CURRENT CIRCUITS—
Electrical units used to measure current, voltage, resistance, and power; batteries; generators; series and parallel circuits; power and heating in electrical circuits; fuses and protective devices; ammeter, voltmeter, ohmmeters, shunts, and multipliers; physical structure of resistors; voltage dividers.

ALTERNATING CURRENT CIRCUITS—
Alternating current waves; frequency and wave form; A. C. meters; inductances and their behavior under changing current; physical structure of inductances; condensers and their behavior under changing voltage; physical structure of condensers; reactance; addition of sine waves; phase relations; impedance; power and power factor; series and parallel circuits; series and parallel resonance; mutual inductance and transformers; auto transformers; physical structure of air core and iron core transformers.

VACUUM TUBE THEORY—
Electron Emission—physical nature; direct and indirect heated cathodes; Diodes—characteristic curves, plate resistance; Triodes—characteristic curves, amplification factor and mutual conductance; Multi-grid tubes—reasons for their use, characteristics curves, care of tubes and practical limitations on life.

VACUUM TUBE APPLICATIONS—PART I—
Rectifiers; power supplies; amplifiers—resistance coupled, impedance coupled, transformer coupled; oscillators; cathode ray oscillographs; sweep circuits.

WIRE TELEPHONY AND AUDIO SYSTEMS—
Nature of sound; microphones—carbon grain, magnetic and crystal; telephone receivers and loud speakers; multistage audio amplifiers with matching transformers. Simple telephone systems.



Block diagrams are used to show sequence of circuits. This one represents a superheterodyne receiver.

PROPOSED EXPERIMENTS

1—Soldering exercises and the use of radio repair tools.
2—Series and parallel D. C. circuits using voltmeters and ammeters—power and use of fuses. Overheating of resistor elements.
3—Wheatstone bridge and ohmmeters.
Series and parallel circuits using bridges and ohmmeters.
4—Study of A. C. waves with cathode ray oscilloscope.
5—Reactance of inductances and condensers.
6—Series and parallel A. C. circuits.
Voltage and current triangles and impedance.
7—Series and parallel resonance.
8.—Iron core transformers at low frequencies.
9—Tuned air core transformers at radio frequencies.
10—Electron emission.
11—Diodes.
Characteristic curves and measurement of plate resistance.
12—Triodes and multigrid tubes.
Measurement of amplification factor and mutual resistance —characteristic curves.
13—Power supplies—wire up with soldering irons.
14—Audio amplifiers.

INTENSIVE RADIO TECHNICIAN TRAINING COURSE
FUNDAMENTALS OF RADIO—PART II
Night School

16 weeks—total of 144 contact hours plus 96 hours of home study

Study Topic	Recitation Hours	Laboratory Hours	Outside Hours
Elements of radio waves ...	6	1	6
Radio communication system using amplitude modulation	8	2	8
Vacuum tube applications, Part II	18	13	18
Radio transmitters using amplitude modulation ...	10	13	10
Radio receivers using amplitude modulation	15	13	15
Frequency modulation	15	2	15
Radio propagation and antennas	24	4	24
	96	48	96

NOTE: 48 "laboratory hours" to include 18 hours of supervised study and computation.

Object—To impart additional basic radio knowledge to students who have completed Course I.

Prerequisites—Course I.

Additional Study for Operator's License: Students who wish to take the examination for Commercial Radio operator's license should also study and become familiar with the following:

A—Study Guide and Reference Material for Commercial Radio Operator Examinations (obtainable for 15 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.).
B—Rules and Regulations (Title 47—Telecommunication—Chapter I), Part 13—Rules Governing Commercial Radio Operators (obtainable for 5 cents from the Superintendent of Documents, Washington, D. C.).
C—Radio Operating Questions and Answers by Nilson and Hornung (obtainable from libraries or it can be purchased for $2.50 from McGraw Hill Book Co., Inc., 330 West 42nd Street, New York City).

DETAILED OUTLINE

ELECTROMAGNETIC TRANSMISSION—
Fundamentals of electric waves—velocity, frequency (spectrum), wave length; method of radiation and reception; antennas—order of dimension.

RADIO COMMUNICATION SYSTEM USING AMPLITUDE MODULATION—
Block diagram of component elements; Transmitter—oscillator, modulator, amplifier, antenna; medium; Receiver—antenna, selective circuit, radio frequency amplifier, detector, audio amplifier, reproducer; C. W.; I. C. W.; phone transmission.

VACUUM TUBE APPLICATIONS—PART III—
Amplifiers used in radio transmitters—tuning requirements; modulators; detectors—crystal and tube.

RADIO TRANSMITTER USING AMPLITUDE MODULATION—
Block Diagram—crystal oscillators; radio amplifier; modulator—code and audio; simple coupling antenna.

RADIO RECEIVER USING AMPLITUDE MODULATION—
Block diagram of tuned R. F. receiver; tuning; multistage R. F. amplifiers; tendency to oscillate and means of overcoming; shielding; screen grid tube; Heterodyne reception of C. W. waves; block diagram of superheterodyne receiver; advantages; principles and methods of mixing; noise limitation on sensitivity of a receiver.

FREQUENCY MODULATION—
General principles and advantages; block diagram of transmitter; block diagram of receiver; use of limiter and discriminator.

RADIO PROPAGATION—
Polarization of waves; how radio waves are transmitted around the earth; noise, static and manmade; utility of different portions of frequency spectrum; antennas, vertical, loop, directional arrays; application to direction finders. (Stress ultra-high frequencies.) Connections between antennas and transmitters.

PROPOSED EXPERIMENTS

1—Sweep Circuits—Wire up with soldering iron.
2—Simple telephone circuit.
3—Public address system.
4—Radio Frequency Amplifiers—Class A.
5—Radio Frequency Amplifiers—Class C (include neutralization)
6—Diode detectors (crystal and tube).
7—Modulators.
8—Heterodyne reception.
9—Service men's equipment and location of troubles.
10—Line up of Intermediate Frequency Amplifier.
11—Standing waves on wires.
12 to 15—Experiments to be determined by local facilities

. . . — . —

someone inside that tank is listening for a radio message

NO sound on earth can be compared to the crash and thunder of this twenty-eight ton monster roaring into action! But one man of the crew—*the radio operator*—demands "quiet!" For vital short-wave radio instructions *must* come through clear and ungarbled every time.

Yet the tank's own generator, ignition system, electrical equipment, create enough interference to "jam" even the clearest shortwave signal. The job of TOBE FILTERETTES is to suppress this Man Made Static *at the source.* And TOBE FILTERETTES are doing this job on many radio-equipped units of both the Army and Navy.

The Capacitor of the Future

Incorporated in every TOBE FILTERETTE design is the equally famous TOBE CAPACITOR—made with the skill and care of good New England craftsmanship. *Today,* TOBE is meeting the wartime needs of our country's largest manufacturers. *Tomorrow,* American Industry can look to TOBE as a dependable source of capacitors and noise suppression equipment.

Peaceful Radio in Peace Time

Your radio pleasure need never be marred by the blurring distortion of electrical interference. In homes, radio-equipped cars and boats, TOBE FILTERETTES will help afford enjoyable reception—clear of Man Made Static. Some day, as you tune in on long or short wave, you'll say, *"No Noise Please! Thanks to* TOBE FILTERETTES!"

The compact TOBE FILTERETTE *. . . the result of fifteen years' experience in the suppression of radio noise created by electrical interference of all kinds. It replaces bulky filters and costly shielding methods.*

TOBE DEUTSCHMANN CORP.
TOBE
CANTON · MASSACHUSETTS

Tobe Filterette noise suppressing systems are used on the M-3 Tank illustrated above, as well as Jeeps, Command Cars, Weapons Carriers, Half Tracks, Torpedo Boats, Coast Guard Vessels, etc. Developed in collaboration with U. S. Signal Corps Labs., Fort Monmouth, N. J.

Concentration of Skill!
PAR-METAL Specializes
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•CABINETS
•CHASSIS
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for ELECTRONIC APPARATUS
Specialized skill — that is something you cannot specify. It's "in the blood". Par-Metal has it by virtue of years of concentration on making metal housings for sound equipment. — Send specifications; or write for our Catalog No. 41.
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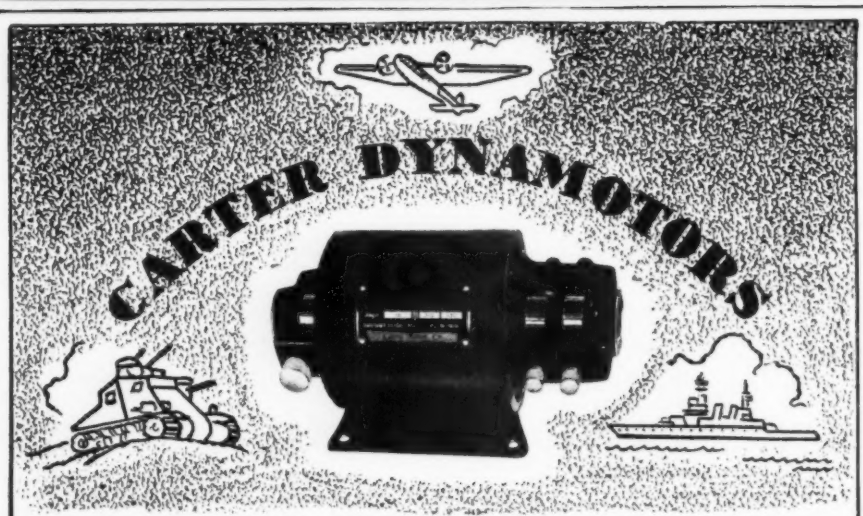


ARE DOING THEIR PART ON LAND —IN THE AIR—AND ON THE SEA

The knowledge gained from the long years of experience in the designing and manufacturing of Dynamotors is now proving most valuable in all branches of the armed forces.

As the result of a greatly expanded Research and Development Department, many new and original designs of rotary equipment will soon be available to do their part in supplying efficient and dependable service.

Write to-day for the new complete catalog No. 100—illustrating and describing Carter Standard and Multi-Output Dynamotors, AC and DC Permanent Magnet Generators, Magmotors DC to AC Converters, Permanent Magnet Hand Generators and Genemotors.

Carter Motor Co.
Chicago, Illinois

1604 Milwaukee Ave. Carter, a well known name in radio for over twenty years. Cable: Genemotor

Radio In This War

(*Continued from page* 165)

by authoritative speakers seen and heard on the air.

Internationally, radio's short waves are freedom's long-range voice. American radio beams are spearheads of victory. They counteract enemy propaganda. They link the United Nations and contribute to hemispheric solidarity among the Americas. Short-wave beams flash to the Orient and Australia, to the sands of Libya and Egypt, across the Nile and River Don, to the Caucasus and Ceylon, from the Coral Sea to Bering Sea, from Iceland to New Zealand, from Midway to Greenland, from Madagascar to the Aleutians.

The people in invaded lands know what it means to hear Freedom calling from America as the broadcasts penetrate the blacked-out areas of the world. Radio's beams kindle the beacon of Democracy. The glow in each radio tube is a torch of liberty. That light must never go out.

No matter how black the night, short-wave radio from the United States keeps free people everywhere in communion. From a Frenchman out of the dismal dark came this recent plea to an American broadcaster, "I beg of you, bring this understanding to us each day, more and more. God bless you, and thanks so much for being with us."

When victory is achieved, we shall look forward to a world at peace that will need to be reconstructed. New industries and new services will demand trained men to meet civilian needs in the post-war period.

As we look ahead, it is interesting to recall that the first World War stimulated development of the radiophone, which opened the way for the new art of broadcasting. In the United States it has grown into a billion-dollar industry employing hundreds of thousands of persons. This war is giving impetus to the development of television, high-frequency communications, and the miraculous field of electronics. Older systems and methods are certain to be revolutionized, creating new opportunities for young men after the war.

We definitely entered the Radio Age after World War I, and we are now on the threshold of the Electronic Age. Just as our fathers and their fathers lived to see electricity light the world and electrify many household appliances, so the young men of today will see many devices and services electronized in their lifetime. As practical training in the Signal Corps and in the Navy during the first World War equipped men to take advantage of new opportunities, so today the sons of these men are being trained for new opportunities in the better world we hope for and struggle to secure.

. . . — . —

Tom is meeting familiar faces

EVEN 'OVER THERE'

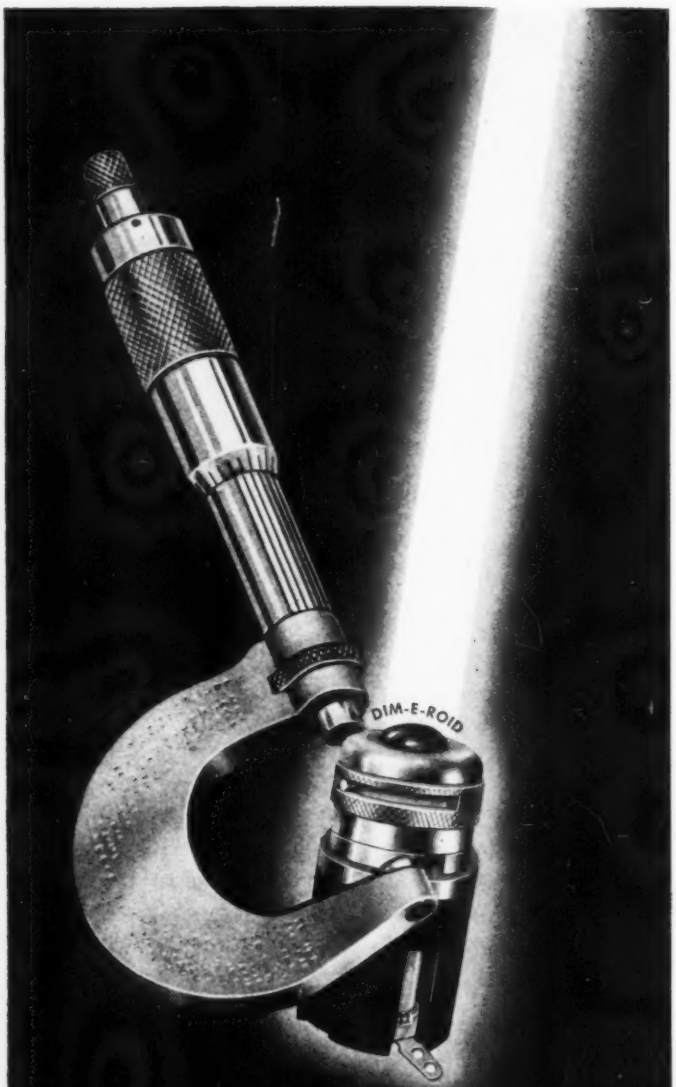
TOM'S background in radio now stands him in good stead in the Signal Corps. Starting as a "ham", then a communications engineer . . . he knows how to spot and correct trouble. From the day he "joined up" he's been thoroughly at home in his new job. Even the test instruments he works with are duplicates of those in the shop back home. They bear the same name he's always banked on for measurement dependability since he built his first "ham" transmitter. And now that he's abroad, he's surrounded by these same familiar instruments even on the equipment and in the repair depots of our allies. For throughout the allied countries, too, the mark WESTON is the accepted symbol for dependable electrical measurement. Weston Electrical Instrument Corporation, 615 Frelinghuysen Avenue, Newark, New Jersey.

Priority restrictions have necessarily greatly curtailed the supply of WESTON instruments for many industrial needs. *Uncle Sam stands firmly at the head of the instrument line!*

To the great majority of instrument users not now engaged in war production, however, this has meant little, if any, inconvenience. The WESTONS they now have in service will see them through for the duration and beyond. *Long-life dependability* is built into every instrument bearing this name.

WESTON INSTRUMENTS

Laboratory Standards • Precision D-C and A-C Portables • D-C, A-C, and Thermo Switchboard and Panel Instruments • Instrument Transformers • Sensitive Relays • Specialized Test Equipment • Light Measurement and Control Devices • Exposure Meters • Aircraft Instruments • Electric Tachometers • Dial Thermometers



ACCURACY IS NO ACCIDENT!

Steady hands and accurate instruments produce DIM-E-ROID polarized, adjustable panel lamps. These are the factors which make for unerring constancy of performance of these tiny beacons in the instrument panels of American fighter and bomber planes. DIM-E-ROID performance is characteristic of all products manufactured by AMERICAN RADIO HARDWARE. Sometime . . . sooner or later . . . our products will again be available for commercial use. Today all our efforts are devoted toward helping to teach the Axis members not to fool around with our Democratic way of life.

BUY WAR SAVINGS BONDS AND STAMPS

ARHCO RADIO PRODUCTS

American Radio Hardware COMPANY, INC.
476 BROADWAY NEW YORK, N. Y.

MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT

Vehicular Equipment

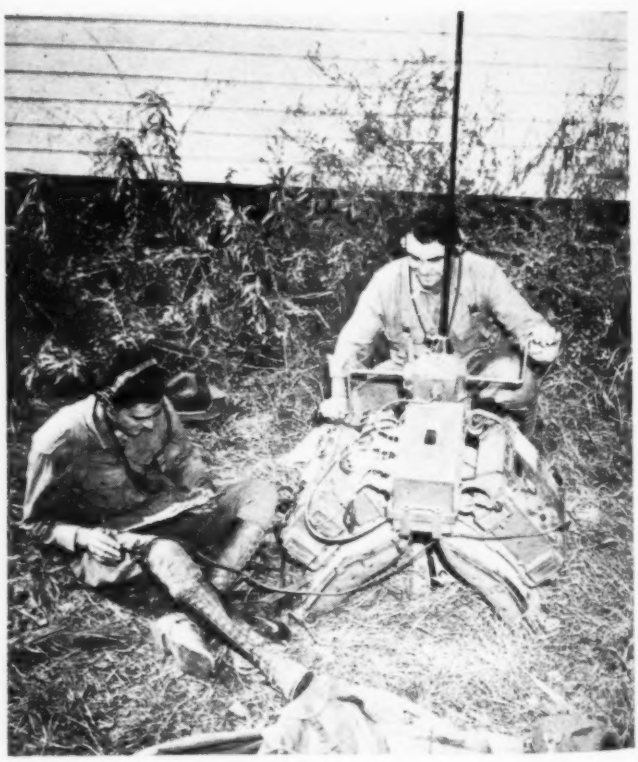
(*Continued from page* 109)

¼ ton 4x4 reconnaissance cars (jeeps), is another story of gruelling test. Physically small and one of the toughest communication units in the Army, it started out in life as an experimentally wired chassis about a year and a half before our entry into the war.

If you had been at the developing laboratory you would have seen circuit after circuit under close examination to find a combination which would produce the best results in the smallest space with the least battery drain.

Many types of tubes were tried, many rejected. One circuit was tried, then another. Finally a circuit looked promising, and model sets were painstakingly turned out by hand. Clamped to the saddle-rack of motorcycles,

All set for its journey but new mechanized equipment is far better suited to the blitz techniques employed in this war.



Designed for field use—this pack set is transported on mule or horseback. Hand-driven generator supplies power.

EVEREADY

TRADE-MARK

RADIO BATTERIES

"A", "B" and "C"

Serve the U. S. Signal Corps

We are proud to say that "Eveready" Radio Batteries, including the famous "Eveready" "Mini-Max" Radio "B" Batteries, have been accepted by the U. S. Signal Corps. Illustrated are a few of the many types of "Eveready" "Mini-Max" batteries now serving the various branches of our fighting forces.

The Batteries Illustrated Above Made Portable Radio *Really* Portable

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

The words "Eveready" and "Mini-Max" are registered trade-marks of National Carbon Company, Inc.

TO OUR DEALERS

Naturally, the Services came first. At the time this magazine went to press, however, there was available for civilian use a limited supply of "Eveready" "Mini-Max" batteries which you may be able to obtain through your regular channels.

they were beaten across washboard roads and hammered by mechanical vibration machines. Tubes broke, coils came to pieces, solder would not hold. These were replaced by tougher parts, and again the sets were sent out on motorcycles and were beaten again. Sometimes a set would return to its base with smoke coming from its chassis, its parts hot from short circuited batteries. Again the engineers would work over the set, and, finding the failing parts, make replacements once more.

Finally, one by one, troubles narrowed and final models began to take form. But these final models had only begun their testing journey.

You would have seen these sets placed in cold chambers where, as they operated for hours, their performance was under scrutiny by external meters. Rime and frost gathered on chassis as thermometers dropped below zero. Soon operating under arctic conditions, battery voltages began to falter but circuits were still performing. Perhaps a compensator here, a condenser there needed a slight change. This done, the sets passed their cold test.

Then followed heat tests, humidity tests, and immersion tests. The same models were placed in electrically heated chambers where temperatures reached desert conditions. Condensers melted and had to be replaced; resistance passed their dissipation point and more rugged ones were inserted. Again circuits were under lengthy examination by external meters. They would now withstand heat and cold—and send out a signal which, put to the right use, could bring together on the battlefield at the right time and place, a winning combination.

Next, the sets went into steaming humidity chambers, equal to any jungle rainy season of Central America or the Far East. The sets were then immersed in water and placed in the stream of a hard-driving hose. A seal here, a washer there, and the sets had as much protection from the elements as was possible for the size and weight of the set.

The next steps in this contest of endurance were service tests in the field. Models were called on to demonstrate their performance and durability in vehicle-to-vehicle communications over rough terrain; tests were made under interfering high-tension lines, in valleys, in underpasses, from hills. From performance in these places we learned just how they would stack up.

Today, the chances are that any type of set you see or use in vehicular operation—in jeeps, in tanks or in other vehicles—has undergone the same ordeal of test.

Even when these sets roll off the production line and go out into the field, they cannot be regarded by the development agencies of the Signal Corps as a job done and over. Development responsibility is never fully discharged until the set passes into the limbo of the obsolete.

Engineers are sent out to the field to install the first sets out of production. Their performances are watched; reports of failures are requested, along with recommendations for improvement early in the process of production.

This process of continual close scrutiny of the set's performance in the field is of greater importance than the development phase of the set. At last many sets (production sets this time) are in the hands of the ultimate users; and continuous day and night operations in the field reveal needs for refinement, for improvement, and for the elimination of the defects, should they exist. Whenever a weakness is discovered, samples are obtained from the field to determine whether the defect was due to unskilled operation, whether it was peculiar to the individual set, or whether it was a general feature of the equipment. A development project is, therefore, *never* terminated until the set has been completely replaced by a succeeding type of equipment. In fact, it continues at *all times* while the set is used by the Signal Corps.

Changes may be necessary in a set for other causes: Tactical concepts may suddenly change in any war such as this calling for a change in the performance of a given radio; the range of the set may be too great, or it may be too short; its frequency range may need to be shifted for tactical purposes. But all these changes must be very carefully considered, so that real, not fancied nor trivial, improvements are obtained and then only at such intervals and at such well-co-ordinated phases of production that no delay is introduced in production-line flow—the all important objective.

Frequently the same engineering personnel (who have followed the complete cycle of one set through its engineering, service test, and field service life, and thus have acquired knowl-

Still YOUR BEST BET
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Centralab
MIDGET
RADIOHMS
Servicemen recognize the "plus-performance" that these sturdy controls give on every replacement job...Old Man Centralab's good advice to "ALWAYS SPECIFY CENTRALAB" was never more timely than now . . . when it is so important to keep the "radio ears" of the nation properly tuned to the events of these critical moments in our history . . . For smooth, silent, sure attenuation . . . specify CENTRALAB MIDGET RADIOHMS.
CENTRALAB: DIV. OF GLOBE-UNION INC.
MILWAUKEE, WISCONSIN, U. S. A.

From the Bell to the Knockout

PLASTICS PLAY A VITAL PART

Today, the mold mark of the Chicago Molded Products Corporation can be found on the products of these and other companies:

General Electric Company
Curtiss-Wright Corporation
Glenn L. Martin Company
Westinghouse Electric & Manufacturing Company
Kellogg Switchboard & Supply Company
R. C. A. Manufacturing Company
Western Electric Company, Inc.
Zenith Radio Corporation

Communications equipment of the Signal Corps is the nerve system directing the punch of our fighting forces. It's got to be tough, light, absolutely dependable — able at all times to get the message through.

That's why equipment parts molded of plastics are so prominent throughout the communications web of our armed forces today. From tiny relay boxes and switches to radio housings and telephone handsets, dozens of molded parts bear our mold mark . . . because in days before Hitler, we were actively engaged in developing the production of these types of equipment. We're happy we've had that experience now — and that we can apply it to this vital phase of victory.

Today, our facilities are devoted entirely to our war effort, but naturally, engineering and research work goes on continually. When we've settled our account with Messrs. Hitler, Hirohito, et al, all these ideas and facilities will again be at your disposal.

CHICAGO MOLDED PROD. CORP.

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CHICAGO MOLDED PRODUCTS CORPORATION

1025 North Kolmar Avenue, Chicago, Illinois

edge of the field requirements) are in a most favorable position from a standpoint of experience to supervise the development of its successor. Thus continuity, avoidance of past mistakes, and the accumulation of a large fund of experience are sought, and are at once ploughed back into new equipment to the end that military radio equipment shall be progressively better with each new design.

The *uses of vehicular equipment* in the field are several and interlocking: tanks talk to tanks, to jeeps, and to planes. The effective ranges of these new radio equipments hence vary somewhat, depending on the application, just as do the ranges of different types of cannon. It's an obvious waste of space, weight, mobility, and ammunition to use a cannon when a machine gun is the weapon for the job. By the same token, tank reconnaissance radios are not long range units, but are designed to the job they're fitted for.

Where long distance contacts are required, special flexible and mobile sets have been developed. They can be operated efficiently while the carrying vehicles are traveling at high speeds. Or the vehicle can be stopped and the entire radio station removed and set up as a field station.

Some of the smaller vehicular sets also can be disconnected, detached, and removed from their carrying vehicles in a short time and either placed in another conveyance, or carried and set up as fixed field-stations. This ability serves a number of tactical purposes. First, if the carrying vehicle is disabled in action and the radio intact, the operator can unclamp his radio, take it to cover, and continue his communications. Or the radio in question can be removed and used for purely field purposes.

Taking stock of how far we've come toward providing our troops with equipment *that will get the job done*, by far and away the largest credit belongs to the thousands of patriotic citizens who, with their brains and their skill, have designed the equipment and are now producing it in quantity. The hours have been long and the work has been hard. Layout men, draftsmen, wiremen, shopmen, engineers—no one knows how many nights they worked all night through, first to get the development models out, then to get the changes made. We can't forget the vital role that management has filled in this crisis: taking risks on its own to save time and be ready—putting the job ahead of any personal interest or profit.

There were new tools to be turned, new dies to be cast, new assemblies to start rolling. It meant sacrifice by management and sacrifice by labor. Together, they are the ones who have done it; we've only pointed the way. This army of skilled, zealous, and resourceful citizens who turned from their peace time design and fabrication of radio and telephone equipment is the army to which credit is due.

Here's to 'em—the finest industry on earth.

. . . — . —

Aviation Radio

(*Continued from page* 127)

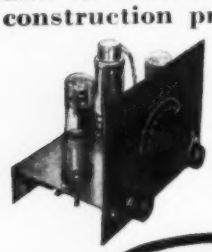
tion a school conducted by highly trained engineers of the Laboratory for instruction to civilian employees on radio communication and detection equipment. The personnel for this school are selected by Service Commands throughout the country and, upon the completion of the course (which is usually six weeks in duration) they are ordered elsewhere, either within or without the United States, for duty in connection with the maintenance of radio equipment.

More, perhaps, than any other art to receive new impetus from our war effort, the art of radio is demonstrating astonishing applications of principles hitherto confined to the dusty tomes of pedantic theory or to the "Buck Rogers" realm of fantasy. Though it is much too early to predict the ultimate form these applications will take, it can safely be said that in addition to offering new safety and certainty in air travel, they will open wide avenues of use in many civilian pursuits.

. . . — . —

Train 'em Faster with MEISSNER RADIO KITS

Signal Corps Schools **know that in order to speed up radio training they must use kits that have been specially designed for student training purposes . . . Meissner radio kits are precision engineered for classroom use, saving valuable time for both instructor and student. Meissner pictorial Wiring diagrams simplify construction problems in basic radio training.**



Meissner **one, two and three tube add-on Kits are ideal for the beginner in classroom work . . . starting with a one tube Kit, students can, with the add-on features, construct two and three tube receivers—available for both AC and DC operations. Six and nine tube kits are available for the advanced student.**

See your Meissner distributor for special SCHOOL NET PRICES

Meissner

MT. CARMEL, ILLINOIS

"PRECISION BUILT PRODUCTS"

So much—So quickly...BY RADIO!

Radio is the voice and ear of modern war.

Radio follows the flag and the fleet—locates the enemy—flashes urgent orders—safeguards the convoy—guides the bomber—directs the artillery—manoeuvers the tank.

From submarine to flying fortress, from jeep to anti-aircraft gun, radio is on watch, always ready to speak and to listen—to give warning and to guide.

Radio brings information and relaxation to the free—courage and understanding to the oppressed.

Radio fights on every front!

Radio Corporation of America

PIONEER IN RADIO, ELECTRONICS, TELEVISION

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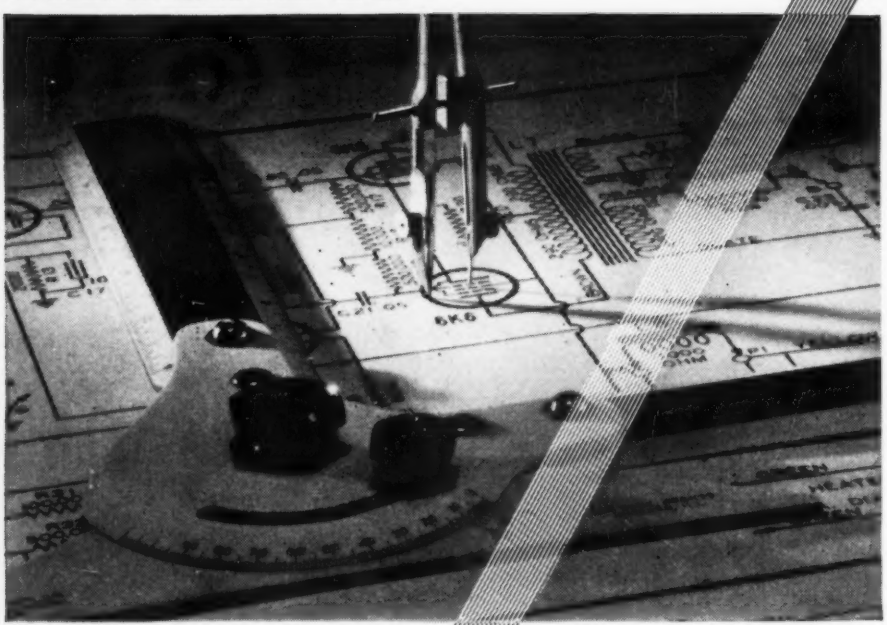
The IMAGIN-EERS who created RECORDIO turn to weapons



IMAGIN-EERING is a new word in the American vocabulary. Its meaning, however, has long been understood and practiced at Wilcox-Gay. Wilcox-Gay engineers have the imagination AND the "know-how" to put it to practical use. Wilcox-Gay Recordio is a good example of imagination and sound engineering working hand-in-hand.

The talent that created Recordio has now turned to weapons. Wilcox-Gay engineers have joined forces with the vast army of engineers throughout America who constitute America's most prized resource. They're the men who will out-think and OUT-IMAGINE our enemies.

WILCOX-GAY CORPORATION

CHARLOTTE, MICHIGAN

"Producing for war . . . planning for peace"

Wire Communications

(*Continued from page* 105)

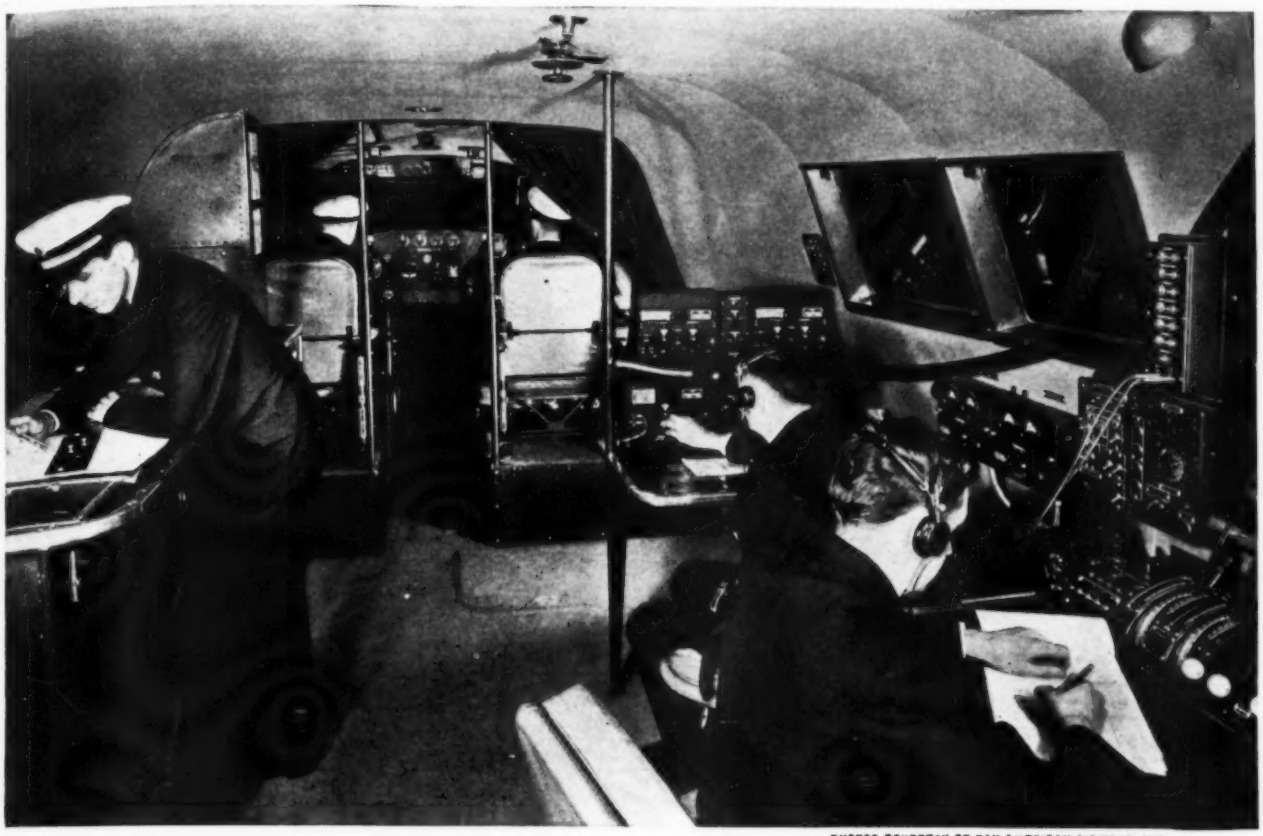
does not lend itself to the normal means of installation then used or used at the present time. Through close co-ordination with manufacturers and utilization of all facilities, it is anticipated that this difficulty will not be encountered again.

In addition to the types of wire referred to above, long range field wire and long range cable for transmitting carrier frequencies are being provided. These types incorporate high tensile strength, shielding, resistance to rough handling, and flexibility without sacrificing of other desirable electrical characteristics. Along with the endeavors of the Signal Corps to improve field wire and cable, it has been necessary to conserve strategic and critical materials which, if used in larger quantities, would undoubtedly simplify design problems. As a result of these efforts, it is estimated that on field wire and cable over 7,000,000 pounds of crude rubber and latex, 25,000 pounds of tin, and 70,000 pounds of zinc will be saved in the next year.

As mentioned previously, wire and cable used by field forces must be flexible so that it can be laid initially on the ground and very rapidly. If practical it is later raised or buried, a plow being provided. During World War I it was laid largely by hand reels or horse drawn wire carts. This equipment must also be used for the recovery of these wire lines where possible. The advent of the automobile has now been fully utilized in varying degrees even though improved hand drawn wire carts and breast reels must still be used. Everything from the well known "Jeep" to two and one-half ton cargo trucks have been put into service for this purpose. Power driven reels on trucks with attached booms can reel out one or more circuits at a very rapid rate. The speediest device now being used is the recently developed wire thrower which as it unreels field wire from a reel on a truck traveling at 35 miles per hour, projects it to the side of the road for a distance of approximately 75 feet and vertically to a height of approximately 40 feet.

Getting the lines away in this fashion is particularly important for wire cannot be laid along the roads and be expected to continue to give service. This reel unit also recovers wire at the rate of approximately 10 miles per hour.

At the outset of World War No. I, wire telephone equipment for tactical use was practically limited to a service buzzer which was a combination of a telephone and high voltage telegraph set. Upon entry into the war, United States troops in Europe used the French monocord switchboard in advance sectors. New portable monocord switchboards of six and twelve-line ca-

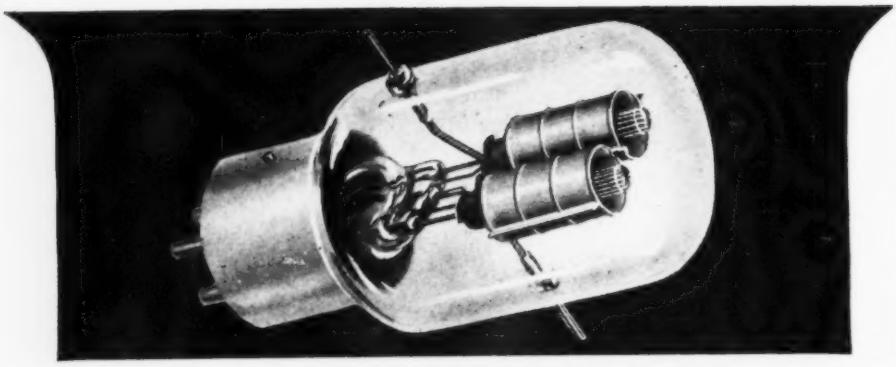


PHOTOS COURTESY OF PAN AMERICAN AIRWAYS, INC.

WHAT IS INSIDE A CLIPPER?

Well, take a look at the picture above. Most of a Clipper's equipment is unfamiliar to the uninitiated, but the clean efficiency revealed in every detail needs no description here. For in a Clipper, no detail is too small to be important, and no alibis are accepted. High as Pan American Airways' standards are, amateurs will not be surprised to know that National parts "measure up."

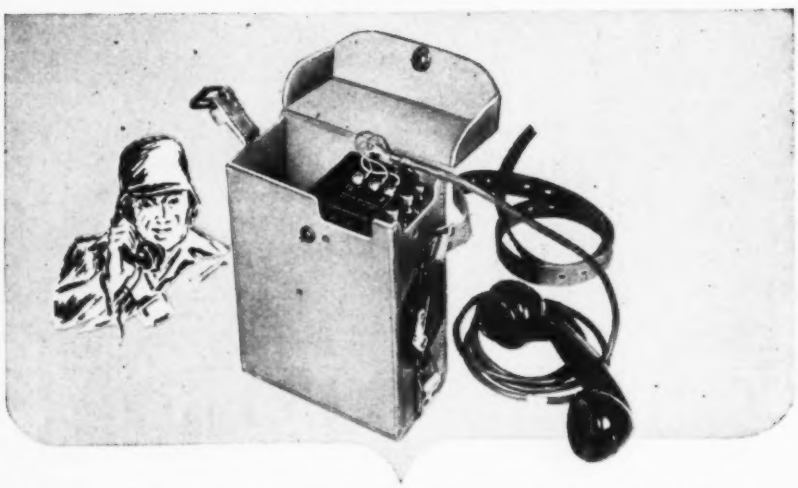
NATIONAL COMPANY, Inc., Malden, Mass.



WAR-SPEED COMMUNICATIONS

—BY WIRE OR RADIO—

CALL FOR CALLITE



Callite quality is an old story to industry. But it took modern, all-out war, where success hinges on *lightning communications,* to gauge the actual measure of Callite quality and dependability.

Callite materials and formed parts have improved the performance of countless electrical and electronic devices in use on world-wide battle-fronts. Typical applications of Callite products are found in the Gammatron tube and Connecticut Telephone field handset shown above.

Callite's extensive experience in research, development and precision production is a match for wartime's exacting conditions. Whether you're seeking higher product quality — or technical assistance with unusual problems—it will pay to call in Callite.

SPECIALISTS in the manufacture of electrical contacts of refractory and precious metals, bi-metals, lead-in wires, filaments and grids—formed parts and raw materials for all electronic applications.

All our materials are subject to priorities. You will facilitate production and expedite deliveries by supplying with your orders properly executed Preference Rating Extensions and End Use data.

CALLITE TUNGSTEN CORPORATION

544 39th STREET — UNION CITY, N. J.

CABLE: "CALLITES" · BRANCHES: CHICAGO · CLEVELAND

pacity have been developed for this purpose and are now being used.

Portable telephone sets, other than the service buzzer, consisted mainly of local battery sets using a standard telephone lineman's handset. These, which were housed in leather cases, had been designed by one of the commercial laboratories for the use of the United States Forest Patrol. Subsequently, they were refined and developed into sets for army usage, the leather case being replaced by a wooden case and a switch-hook being provided. In recent years the set has been redeveloped and refined and in its present form may be used for either common battery or local battery service. The carrying case is now made of either canvas or leather. The equivalent of a commercial handset is used. Safe powered handsets using no battery are also used for short lines.

After our entry into World War No. I the need was realized for a tactical switchboard as distinguished from adaptations of commercial PBX's and the so-called 40 line local battery camp telephone switchboard was developed. This has been replaced by a 20 magneto and 37 common battery line switchboard which is complete in two packages.

For use at army and corps headquarters reliance was placed on commercial equipment until a few years ago. It was then felt that at these headquarters, a readily movable telephone central office was needed and such a system was developed. Its capacity was 30 local battery and 60 common battery lines per position. Connection may be made to other common battery systems — either manual or dial.

While there has been considerable progress in commercial telephone switchboard development in recent years, much of this has been concerned with refinements of the fundamental principles. Most of these added features require additional equipment and, while they would be desirable for army usage, they are not essential and consequently have been omitted in order to increase the portability of the equipment and decrease maintenance. For these same reasons, the use of automatic (dial) equipment has been avoided except for permanent installations.

In 1918 the telegraph system of the U. S. Army lines of communication in France made wide use of ground return telegraph circuits derived by simplexing or compositing telephone pairs on open wire lines. Most of these were manual Morse circuits, often half or full duplex, but in a number of cases page-printing telegraph equipment was operated on a time-division multiplex basis over duplex telegraph facilities derived from composited as well as simplexed lines. Both double and triple duplex multiplex equipment was used, providing respectively two or three full duplex circuits, operating at a speed of 40 words per minute per channel. Direct teletypewriter service

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Help the Signal Corps
"get the message through"

ANTENNA EQUIPMENT
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L. S. BRACH MFG. CORP.

World's Oldest and Largest Manufacturers of Radio Aerial Systems

55-65 DICKERSON STREET • NEWARK, N. J.

to London was provided in that manner from Tours, Paris, and Chaumont, and similar equipment also was used at St. Nazaire, Bordeaux, Bourges, and Nevers.

The printing telegraph service had no counterpart of the modern teletypewriter exchange switchboard. Also there were no teletypewriter machines reliable enough or possessing the characteristics necessary for satisfactory operation in the combat zone.

Forward from GHQ, the telegraph facilities were derived almost exclusively by simplexing telephone circuits which often were rubber insulated twisted pairs. In addition to ordinary d.c. telegraph working, a buzzer-phone employing a tone was employed to some extent, and considerable use was made of the French "Telegraphie-Par-Sol" set in which a weak d.c. controlled the tone heard in a head receiver.

Today, in addition to ordinary d.c. telegraph facilities, the army has equipment for 60-speed teletypewriter service on an exchange switchboard basis, suitable for use both in the combat zone over simplex army field wire and in the rear. The machines are capable of withstanding hard knocks and are much more reliable than those of 1918, besides requiring less maintenance. In addition, they have the features of typebar working, means for making multiple copies, and the handling of printed forms by means of a stationary paper carriage. Telegraph transmission over lines is much superior to what it was in 1918. Teletype networks of considerable complexity are now established with teletypewriter exchange switchboards which can be readily moved and set up in new locations, and high speed repeaters for long lines.

In place of multiplex equipment of the time-division type, the army has the voice frequency telegraph system, previously mentioned which provides four channels in each direction over a telephone circuit which may be of a conventional type or derived from a carrier telephone system. The telegraph channels are obtained by frequency selection, using electrical filters, in contrast to the time-division method employing a mechanical distributor.

For front line use a Signal Corps Set now provides a means for communication by a weak d.c. which controls a tone-producing element connected to a head receiver. The buzzer phone of 1914, as it was known then, would have caused much too much radio interference to be used today.

From the preceding paragraphs, it can be seen that the endeavor of the Signal Corps has been to provide wire communication systems which utilize to the fullest extent current knowledge of the art, and are streamlined to meet the requirements of modern warfare, but reliable enough to function under any conditions from the tropics to Siberia. These systems have been fabricated particularly with the view of not restricting further improvements, and it is anticipated that many unforeseen as well as contemplated improvements will be made.

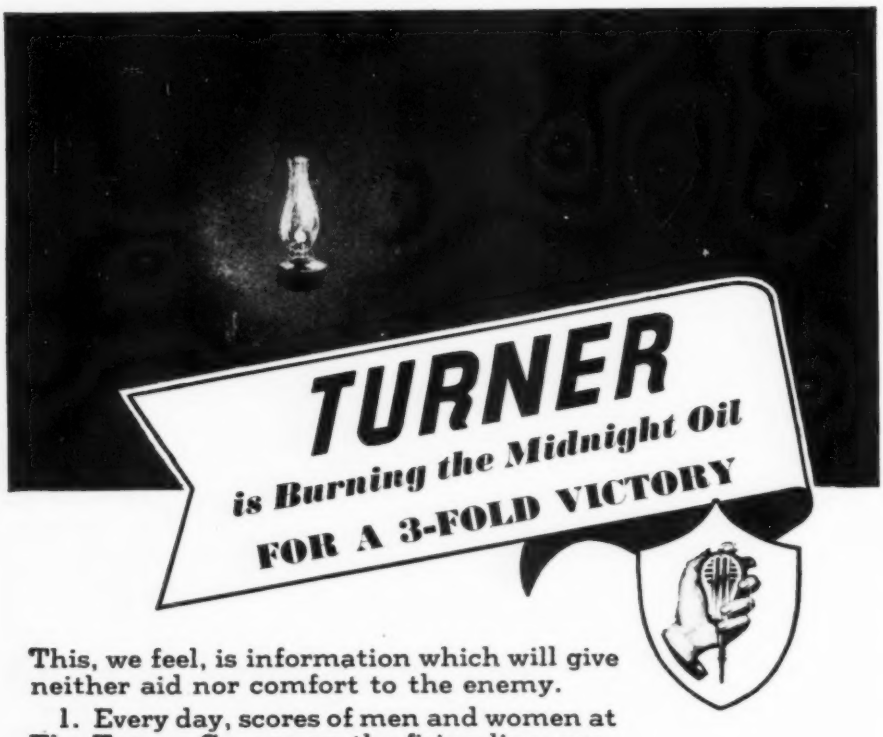
• • • — • —

S.C. in Great Britain

(*Continued from page* 131)

of earlier maneuvers in the United States. In the words of the soldier, this game is being played for keeps, and everyone realizes that.

Supplementing these training activities, the Signal Corps is also responsible for the job of providing communication between the theater of operations and the United States, and between many points within the British Isles. The British Government has made its civilian, Army, and Air Force telephone and telegraph systems available to the American Army. They have been most generous and cooperative in sharing their circuits. However, existing radio and wire facilities being inadequate for the enormous amount of military traffic thrown suddenly on them with the arrival of the first American forces, the Signal Corps embarked early in the operations upon a construction program to supplement the existing system. Powerful radio



This, we feel, is information which will give neither aid nor comfort to the enemy.

1. Every day, scores of men and women at The Turner Co. are on the firing line, producing vital equipment for battle-front communications units. This, above all, is our present job.

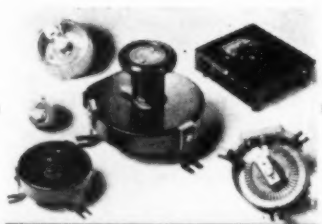
2. Simultaneously, an earnest effort is being made to supply needed Turner microphones immediately to those with priority ratings; also to help present owners of Turner Microphones get the best service, for a longer time, from their present units.

3. When final victory has been achieved, the results of the Turner precision engineering research, now being carried on, will be brought to you in the Turner Microphones destined for a world of friendship and peace.

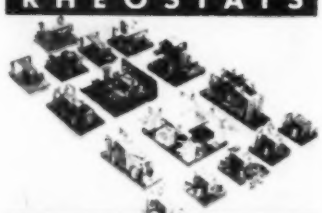
If you have a priority rating, write explaining your communications problem, and we can help you select the Turner Microphone best suited to your needs. We'll gladly send you, too, any information on how to make your present Turner Microphone give the best service, longer

CONTROLS THAT SERVE

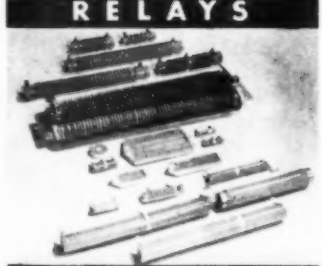
THE ARMY THE NAVY THE AIR CORPS



RHEOSTATS



RELAYS



RESISTORS

ARMY E NAVY

Ward Leonard is in a unique position. Practically all of the electric controls they made for peace-time service meet urgent needs for war-time production. Manufacturers of equipment for the Army, Navy, and Air Corps will probably find their exact requirements for electric controls in the Ward Leonard Line. Special Controls and Control Assemblies are also available to meet special Requirements. Send for complete data bulletins.

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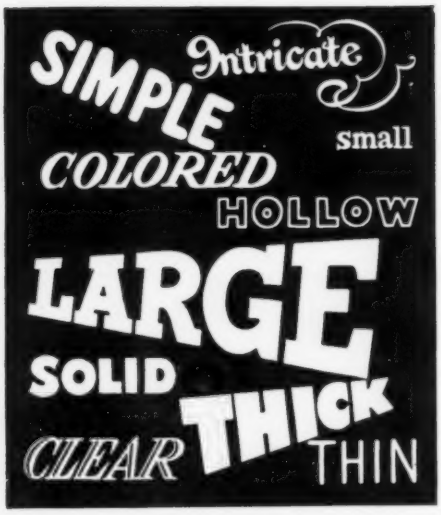
Electric control (WL) *devices since 1892.*

WARD LEONARD ELECTRIC COMPANY, 47 SOUTH STREET, MOUNT VERNON, N. Y.

Whether your design is



..TRY GLASS!

ARE you stumped by the lack of critical materials? Try glass!

Is the product you need large or small . . . square or round . . . thick or thin . . . simple or intricate . . . hollow or solid . . . opaque or transparent . . . colored or clear . . . thermally and chemically resistant . . . mechanically strong . . . a good dielectric? Again we say—try glass! Glass can give you each of these qualities and more.

In the electrical insulation field alone, many urgent problems have been solved recently by Corning's ability to make glassware in sizes and shapes and with special characteristics undreamed of a short time ago.

Why not write us? We're busy—and how!—but never too busy to try to help you solve a problem that's important to America. Write Insulation Division, Corning Glass Works, Corning, N. Y.

DO YOU KNOW HOW HIGH GLASS RATES AS AN INSULATING MATERIAL?

PROPERTY	BOROSILICATE GLASS	LOW-LOSS STEATITE	PORCELAIN	CELLULOSE ACETATE	PHENOLIC RESINOID
High scratch hardness	6	5	3	1	2
Low thermal expansion	6	4	5	1	2
High dielectric strength	5	2	1	3	4
Low dielectric constant	6	3	5	4	1
High volume resistivity	5	4	3	2	1
Total point score	28	18	17	11	10

Pyrex Insulators
BRAND

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

Directing communication activities of American Forces in Britain: Brig. Gen. William S. Rumbough and Col. J. V. Matejka, Signal Officers.

stations are springing up in well-concealed locations, and hundreds of miles of new wire lines for teletypewriter and telephone service are being strung. Smoothly coordinated with existing British plans and equipment, this work is progressing in a highly satisfactory manner.

The accompanying pictures are the first of their kind to be released from the European Theater of Operations. They show as much as our censors permit. The full story of the Signal Corps in this war will be told in words and pictures only after the conflict is won.

. . . — . —

W-A-R and Nerves of War
(Continued from page 130)

trical bookkeeping over long distance wires.

Traffic personnel of the Signal Corps during recent months has been active in formulating projects for the installation of this kind of service in parts of the Army's farflung procurement system. Supervising the engineering, supplying funds, and making final arrangements, the Signal Corps men worked with the International Business Machines Corporation, whose engineering work had made the system possible, in the establishment of long distance accounting for the Air Forces. The system consists of a combination of teletypewriter and IBM machines so designed that the same perforated tape will send a message over wire and at the same time provide for the automatic punching of inventory cards and their correction to up-to-date totals, both at the sending and at the receiving station. The Traffic Division is following the operation of the system to study its efficiency and adequacy to meet current conditions.

. . . — . —

Military Radio Design
(Continued from page 110)

to operate both in the sub-zero arctic winter and in the tropical jungle during the monsoons. It will be transported from place to place by any available means, including trucks, pack-animals, motorcycles, ships, and aircraft. It may be powered by batteries which have just left the factory, or by those which have lain in storage for months—from an automobile battery in any possible condition, under charge or discharge—from power lines having almost any voltage and frequency—or when things are really tough, by Army means applied by a soldier at the crank of a hand generator. In spite of these conditions, the set is expected to work, not sometimes, not most of the time, but all the time!

Every military radio set must be designed so that it can be operated by soldiers having a minimum of special training in its use. The addition of a few gadgets on the panel which may improve performance somewhat under some conditions, may also be the cause of trouble at a critical moment because the operator did not fully understand their use. A military radio set must be designed so that it can be speedily put into mass production with a minimum of special tooling, and a minimum of special machine operations. Above all, the design must be rugged so that the troops may have confidence in the obsolute reliability of their communication, regardless of its age or previous hard service.

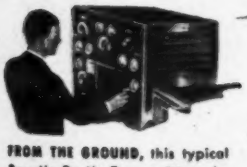
To achieve a satisfactory result, the designer must know, understand, and appreciate these conditions. They must be kept in mind constantly throughout the design and production of the equipment. It is often said that in the design of equipment for home entertainment purposes, "Good enough is best." For the Army, where life or death of our soldiers may depend upon the operation of one radio set, the best is not always good enough.

The development of a new type of equipment begins with a set of military characteristics. These are a statement of the purpose for which the new set is required and of the conditions under which it is expected to operate. They do not form technical specifications and do not tell the designer how to accomplish the required result. They usually impose very severe restrictions upon the design such as a maximum allowable size, weight, and antenna length, a minimum acceptable transmission range and battery life, or other seemingly impossible or contradictory requirements. A designer face to face with a set of military characteristics for the first time is apt to wish that he had chosen another profession.

From the military characteristics to

The Seeing Eye of "THE INVISIBLE CREW"

TARGET FOR TONIGHT: a map-dot deep in enemy territory. No beams, no beacons . . . yet, "The Seeing Eye" of ***The Invisible Crew*** will guide the fighting men of this American warplane to their objective and back. Aloft in darkness, "The Seeing Eye" — the Bendix Radio Compass — sights a far-off radio signal and points the course. Others of ***The Invisible Crew,*** Bendix precision instruments, accessories and controls, help to keep that course and perform many more tasks of flight and combat. Members of ***The Invisible Crew*** back our fliers' skill with superhuman senses and strength on every American plane. Thousands of Bendix workers, by putting precision into high-speed production, help our invincible crews hit the Target for Tonight — and the Target for Tomorrow — *Victory.*



FROM THE GROUND, this typical Bendix Radio Transmitter airbase installation flashes orders "upstairs" with the speed of light.

THE VOICE AND EARS OF "THE INVISIBLE CREW"

BENDIX RADIO DIVISION

THE INVISIBLE CREW

Bendix

AVIATION CORPORATION

IN THE SKY, light, compact Bendix Aircraft Receivers and Transmitters keep crews in constant contact with base and other ships.

Join America's invincible crew! Fly to Victory with the U. S. Army, Navy or Marine Corps. If you are between 18 and 26 apply for pilot training to your nearest Recruiting Station.

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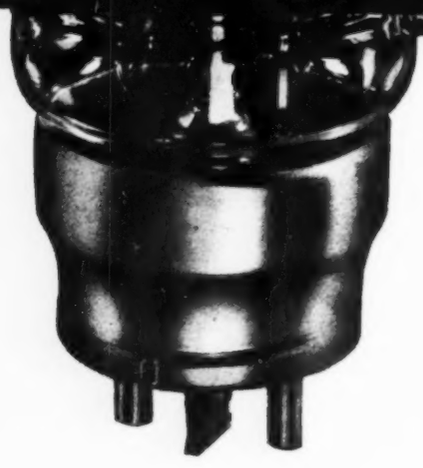

Serving as EYES, EARS and VOICE

Amperex engineers have distinguished themselves through exclusive developments in the design and structure of ultra-high frequency transmitting tubes. These developments are now incorporated in equipment vital to the prosecution of the war.

Engineers and radio technicians, in military services and in government design laboratories, have an opportunity to observe the dependability of Amperex tubes, operated, in many instances, under most difficult conditions.

AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET **BROOKLYN, NEW YORK**

production, the development proceeds through several phases. First, "breadboard" models are constructed and tested until a circuit is found which promises to give the required performance. Then begins the choice of components. Every item must be chosen with care to determine that it will withstand long, hard service under every conceivable condition. Layout drawings are prepared showing the assembly. Sometimes many trial layouts are made. Wooden models are often prepared and loaded to the estimated weight of the set. These models are mounted in vehicles and carried about to see that the size and arrangement of the controls are satisfactory, and that the set will fit into the required spaces.

When all this preliminary work has been completed, the construction of service test models is begun. Every step in this construction is under engineering supervision to determine that the simplest and improved methods of assembly are employed and that the design is capable of duplication by mass production methods.

The completed models are given rigorous laboratory and field tests to determine that their performance fulfills the military characteristics and that the set will withstand all conditions of service. The sets are frozen in special refrigerators to duplicate Arctic conditions, and steamed in a "Turkish Bath" to duplicate the tropics. They are bounced for days over the roughest roads in the worst of dirt and dust, and left standing in the rain. When the defects which these tests reveal have been corrected, the sets are ready for service tests.

The service test is performed by the branch or branches of the Army who will use the new equipment and gives them the opportunity to determine that their needs are satisfied. If the sets are approved, procurement specifications are prepared and the designer's job is finished. If the sets are not approved the whole process may have to be repeated.

Today, the designer of military radio equipment is faced with problems which only a short time ago would have seemed fantastic. Although emphasis is in most cases placed upon extremely light weight, the basic light metals, aluminum and magnesium, are not available for radio except in extreme circumstances. Although radio equipment is expected to withstand continued exposure to extreme conditions such as the corrosive action of sea water, the best materials for metal plating are extremely critical. Although military radio equipment is expected to operate under extreme conditions of humidity and high temperature, including heavy rainfall, the best material for insulation and waterproofing, namely rubber, is also extremely critical. Even the very basis of the modern wireless set, copper wire, is difficult to obtain. The energy and ingenuity of the American radio engineer is being exhibited every day in the means by which these problems are being solved. America will soon have "ersatz" radio sets but the performance of these sets must not be "ersatz" in any way.

Many of the problems with which a military radio designer is faced may be illustrated by the Army's famous "Walkie-Talkie" with the development of which the writer was associated several years ago. The need for improved communication between Infantry front line trenches and the supporting Artillery was apparent to every soldier who fought in the front lines in the World War I. At that time communication from the front lines to the rear was maintained principally through telephone lines. When the going was toughest, these lines were usually put out of order by enemy artillery fire. Necessary communication was then maintained principally by runners. The heroism of these runners needs no explanation, but heroism was not enough. Instant and continuous communications were needed to put the artillery fire at exactly the right spot at the right time. Certainly many men died in 1917 and 1918 for lack of a "Walkie-Talkie," but it was not for more than twelve years that a good solution to this desperate problem was found.

In the early 1930's, American amateur radio operators demonstrated the possibility of ultra-high frequencies and resurrected the long-discarded Armstrong superregenerative receiver. An American soldier, a sergeant in the Field Artillery, had the foresight to realize this new development was the solution of the Artillery's old problem. With the aid of what few tools he had available, and with materials and parts, many of which he bought out of his own pocket, the first crude model of the "Walkie-Talkie" was constructed and demonstrated. As a result of these early experiments, military characteristics were prepared and a project for the development of this set was established at the Signal Corps Laboratories. Early models which the sergeant had constructed were carefully examined and engineers set about to eliminate the shortcomings of his designs and to re-design the set for mass production. Twice a group of models were constructed and given rigorous service tests in which the sergeant participated. Finally a satisfactory design was achieved, manufacturing drawings and performance specifications were then prepared, and production was begun. The writer has in his office today the first approved service test model, and also the model for the first production. It is interesting to note that the sets are almost identical with current models and perform with equal efficiency.

When a new type of set is issued to the troops, the designer is faced with a wholly new set of problems. Completely new applications are found for the new set which were never before

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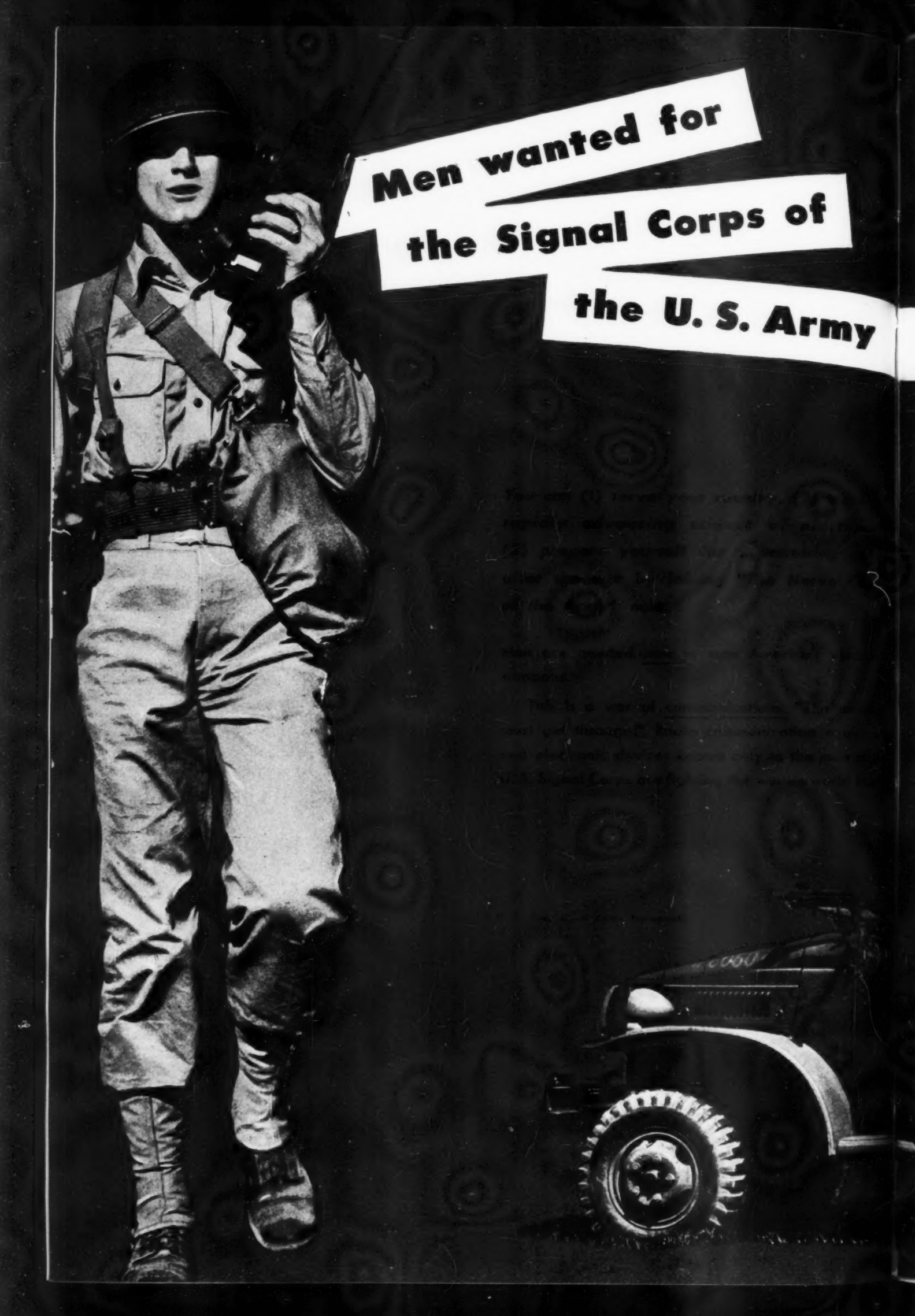
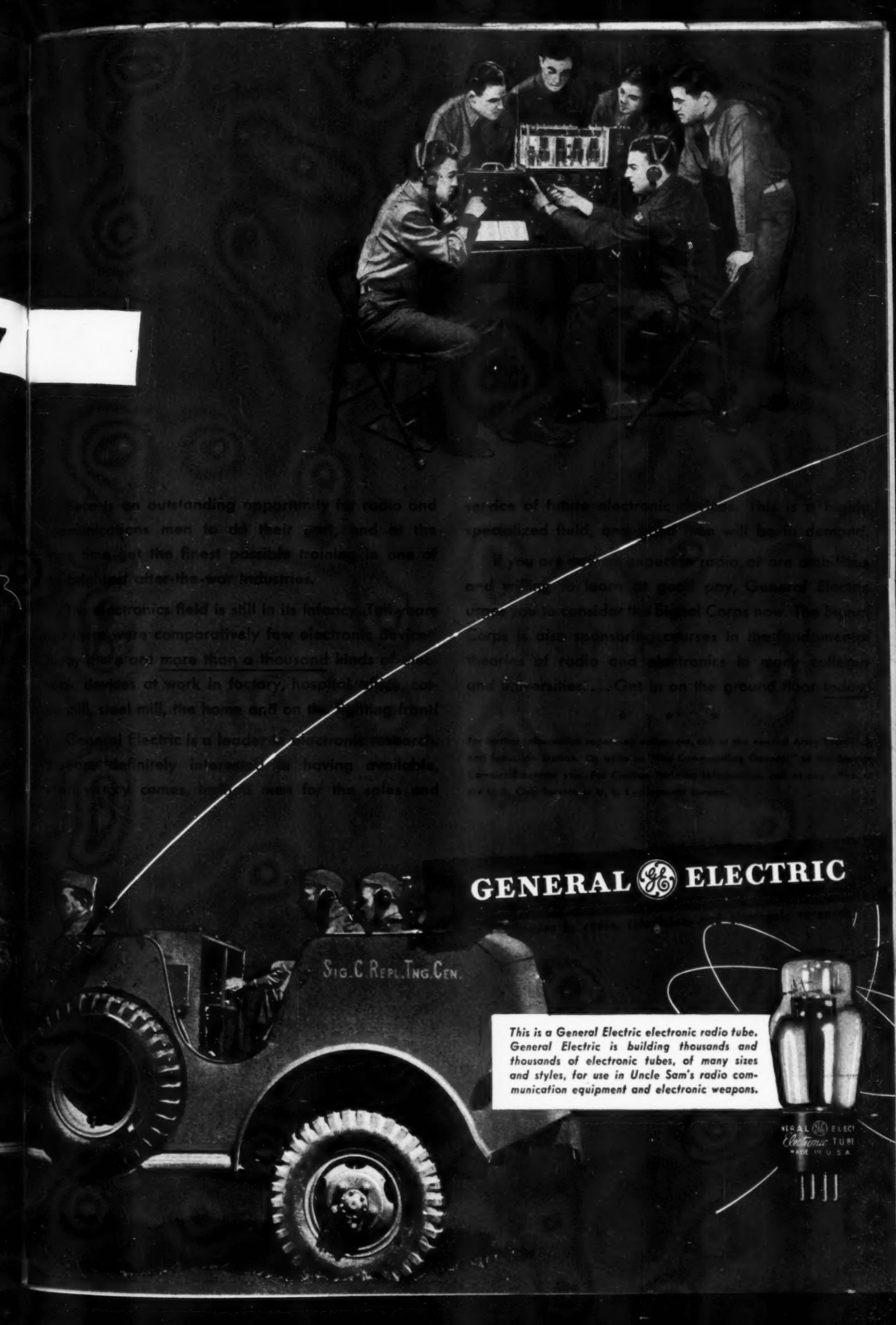
The General Industries Company

ELYRIA OHIO


Men wanted for
the Signal Corps of
the U. S. Army



GENERAL ELECTRIC

This is a General Electric electronic radio tube. General Electric is building thousands and thousands of electronic tubes, of many sizes and styles, for use in Uncle Sam's radio communication equipment and electronic weapons.

contemplated. Sets supposed to be designed for field use will be tried in motor vehicles, tanks, and airplanes. Those designed exclusively for vehicles will be tried in the field. As an example of this—believe it or not—the Army's "Walkie-Talkie" was never designed as a walkie-talkie at all. An American soldier, anxious to get going and too busy to drop his set to talk, is responsible for the discovery which resulted in one of the most important applications of this set. To his successors who are anxious to get going in 1942 and 1943, the best engineering talent of the radio industry is now dedicated. May they never stop!

· · · — · —

Procurement

(*Continued from page* 117)

a definite quantity of complete sets with an established home set radio or other manufacturer, thus gradually educating an increasing number of contractors in the production of Signal Corps equipment. In addition, the subcontracting of component parts was encouraged and numbers of non-radio businesses, such as the refrigerator, camera, typewriter, pin ball machine, vacuum cleaner, etc., industries were converted in part to radio production.

To speed the issuance of contracts, peacetime restrictions were lifted for the duration of the war. Awards were made on the basis of direct negotiation, rather than after weeks of advertising for bids. Renegotiating clauses were inserted into contracts, permitting subsequent negotiations of price revision. In some cases, awards were made by letters to avoid the delay in production which would have occurred through waiting until all terms of a formal contract could be determined. Nothing was permitted to impede the speedy production of combat equipment vital to the success of the Armies of the United Nations. Deliveries of finished articles showed how successful these efforts were. During January, 1942, approximately $15,000,000 of Signal equipment was delivered. The rate continued to mount. By July of this year deliveries were pouring in at the rate of $3,000,000 each day and daily deliveries are continuing to increase.

Despite the successful emphasis on production, the Signal Corps has been careful to avoid a production-at-any-cost policy. Various safeguards, inherent in its procurement system, are always functioning.

BRIGHT NEW WORLD....

Thousands of hams, offered a wide choice of Army duty, are actively forging the bright new world to come. And the Army is giving them new skills with advanced equipment. They are learning what it will take to be important men in that bright new world ahead.

See what the Army has to offer in "U.S.A. Calling!" on page 21 of October QST Magazine and in previous issues. Go to your nearest Army recruiting office, or write as directed in QST. Grab one of these exciting chances to dust off a really hot rig—for the sake of your country, for good pay and for your own future.

★ TERMINAL gladly calls attention to the important place you can have in the U.S. Army —and to the fact that thousands of fellow CQ hounds are already in it —up to here!

TERMINAL RADIO CORPORATION
A Steady Source of All Radio Materiel
85 Cortlandt St., New York, N.Y.
Telephone: WOrth 2-4416

CROSLEY
is fighting on all fronts

CROSLEY is very serious about this war. For one thing, there are many Crosley men — workers who have been with us for years — now in the South Pacific, in Ireland, in Africa fighting this war in the front lines. We have discontinued all of our peacetime business that has made Crosley a household word the world over. We are devoting all of our plants, our facilities, and the time of our people 100 per cent to the war effort. And because Crosley employes are serious and diligent and vigilant in what they are doing we have been commended for our enlightened and aggressive program in the Labor Management War Production Drive by William Green, president of the American Federation of Labor, Donald Nelson, chairman of the War Production Board and other high officials in Washington.

Many of the things we are now designing, engineering, and building cannot be talked about, but the expansion accomplished to meet our greatly increased production schedules, can be taken as a symbol of the great strides we are making to a future that will find Crosley better prepared to make major contributions to the American Home.

Put Your Strength into the Fight by Buying More War Bonds and Stamps

THE CROSLEY CORPORATION

Cincinnati, Ohio — *Richmond, Indiana*

"My dad and I use N.U. tubes in our shop—we found them to be the best quality available and recommend N.U. tubes-to all radio men."

June Johnson
ROY'S RADIO SERVICE
Ferndale, Mich.

WHERE YOU FIND
NATIONAL UNION
YOU FIND BETTER
RADIO SERVICE

PREMIUM *Quality*
TUBES

BATTERIES

CONDENSERS

also *SAV-A-SHAFT Volume Controls, Transmitting tubes, panel lamps, cathode ray tubes, exciter lamps, sound equipment, photo electric cells, sound accessories, dry batteries, flashlight bulbs.*

NATIONAL UNION invites . . .

All radio service dealers to enjoy the benefits of the N. U. Shop Equipment Plan. The latest in tube testers and test equipment are available to you . . .

More than 60,000 completed deals prove the success of this plan. Investigate now.

Ask Your N. U. Distributor or Write

NATIONAL UNION RADIO *Corp.*
57 STATE ST., NEWARK, N. J.

As soon as the strategic communication equipment requirements of the Army are transmitted to the Chief Signal Officer, they are referred to a section of the office that is familiar with current and probable future availability of production facilities and raw materials. This section determines what facility will be used to produce the various items. A directive is then issued to the appropriate field agency (Signal Corps Procurement District or Laboratory) to negotiate with the facility and place a contract for the items. Quotations of manufacturers are analyzed by the contracting officers and awards committees in the district offices. Quotations involving large sums of money are forwarded to Washington for analysis and approval by the Chief Signal Officer and the Commanding General, Services of Supply. The quotations of the contractors are closely scrutinized; schedules of delivery dates are measured by the previous performances of the facilities and prices are studied with respect to costs.

All formal contracts include a renegotiation clause. Renegotiation of price occurs when the differences between estimated and actual cost are revealed by production experience. Frequently, manufacturers whose experience has been better than they had hoped for will voluntarily offer refunds.

Procurement does not end with the placement of orders. Even in World War I the Signal Corps always sought to better its relations with the suppliers of its equipment, and the same is true today. The problems of the manufacturer are the problems of the Signal Corps. Signal Corps expediters are to be found in the thousands of factories turning out equipment. The expediters' particular mission is to help the manufacturer overcome the many obstacles which priority regulations, and material and machine tool shortages entail. The Procurement District Offices and the Office of the Chief Signal Officer in Washington have staffs of officers and civilians who are dedicating themselves to the speeding-up of production. Management service sections have been established to bolster weak or overburdened managements or to assist in financing, where required.

The lack of sufficient manufacturing facilities that can perform the highly involved and difficult tasks demanded by the Signal Corps exists, side by side with the overabundance of facilities capable of turning out simpler Signal Corps Equipment.

The tasks of maintaining present production lines, and finding new ones capable of large-scale, speedy output are ever present. The Signal Corps is still seeking certain types of new production sources. But the relative urgency of this problem has been altered by the appearance of other difficulties, of which the principal one now, and

(*Continued on page* 279)

"Photo By ——"

(*Continued from page* 92)

ing. In subject matter these training films are as inclusive as modern war itself, ranging from "Personal Hygiene" to such topics as "Field Wire Ties" and the fuel system of the Diesel tractor.

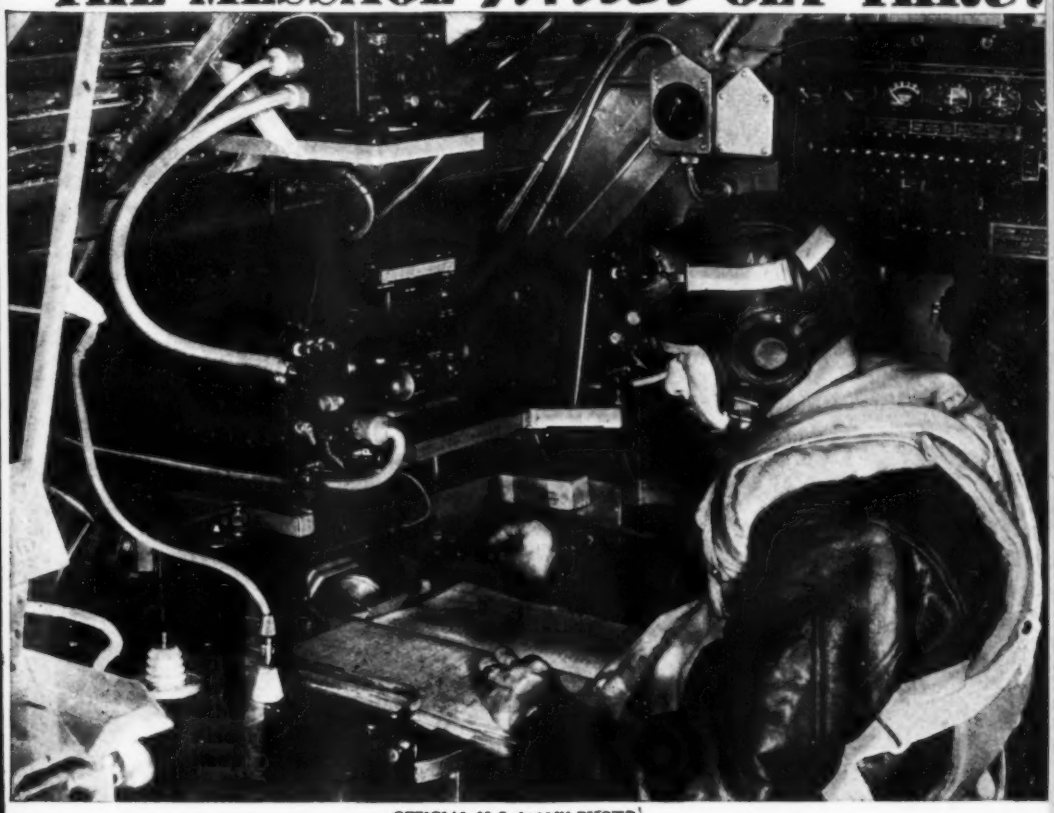
The Field Activities Division of the APS includes the V-Mail Branch, responsible for the utilization of microfilm to reduce letters to and from soldiers overseas to minute dimensions and bulk, thus speeding up the news from the field and from home. Preventing the long delay of letters sent by other and less rapid means, this service contributes greatly to the morale of troops and of their friends and relatives at home. The idea of such service originated during the Franco-Prussian War, but was recently revived in modern form by the Eastman Kodak Company which for some years had been developing microfilm techniques for recording documents and other records compactly. The modern system was first put into operation by Airgraphs, Ltd., which carried on microfilm letter service for British troops.

In May, 1942, the Signal Corps contracted with the Eastman Kodak Co. for similar service for American troops under the name of "V-Mail." Shipment of the V-Mail in reduced or enlarged form is handled by the Army Postal Service of the Adjutant General's Office, reduction to microfilm and enlargement to readable letters being done by personnel of the Signal Corps or of the Eastman Kodak Company. Farflung stations for the handling of the service have been set up in areas where American troops are stationed. Close co-operation is maintained with the British Airgraph service, and arrangements have also been made for the V-Mail service to be used by the United States Navy and Marine Corps.

Signal Corps photographs in the main can use standard equipment, principally still cameras ranging in size from 8x10 inches down to 35 millimeters and motion picture cameras of 35 and 16 millimeters. Being able to use cameras of standard commercial design, the Pictorial Service has concentrated its efforts on modifying these to make them more mobile and to simplify them in accordance with Army requirements, rather than on the design of new equipment. A portable photographic set permitting pictures to be developed in an automobile or other convenient shelter has been designed for special purposes, and a complete identification photographic set has been standardized. The Equipment Branch of the Service is responsible for these developments. The Army Pictorial Service also supervises photographic laboratories at large Army posts throughout the country, provid-

(*Continued on page* 220)

THE MESSAGE *Must* GET THRU!



OFFICIAL U. S. NAVY PHOTO

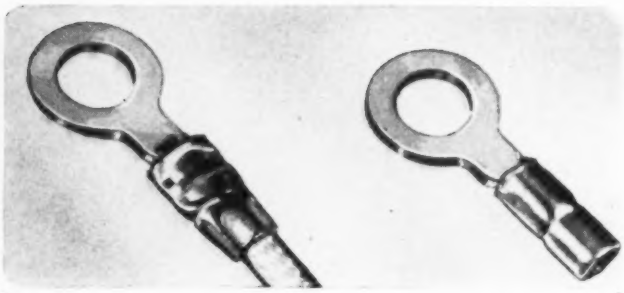
From the shelter of a fox hole . . . or from thousands of feet above the clouds . . . every message *must* get thru. There can be no failure!

History records the determined successes of the U. S. Signal Corps in its important operations. Like the delivery of that "message to Garcia" in the Spanish-American war, it is always understood that there can be no failure. Today this applies to equipment as well as to courageous men.

These days and weeks and months are again and again recording the certain dependability of Kenyon Transformers. There can be *no* failure!

From the days of early smoke signals . . . getting messages thru has been of utmost importance in war.

KENYON
TRANSFORMER CO., INC.
840 BARRY STREET • NEW YORK, N. Y.



AMP "Diamond Grip" INSULATION SUPPORT TERMINAL
— PLUS —
NEW "HAND DIE" CRIMPING TOOL

3 in one Crimping Tool

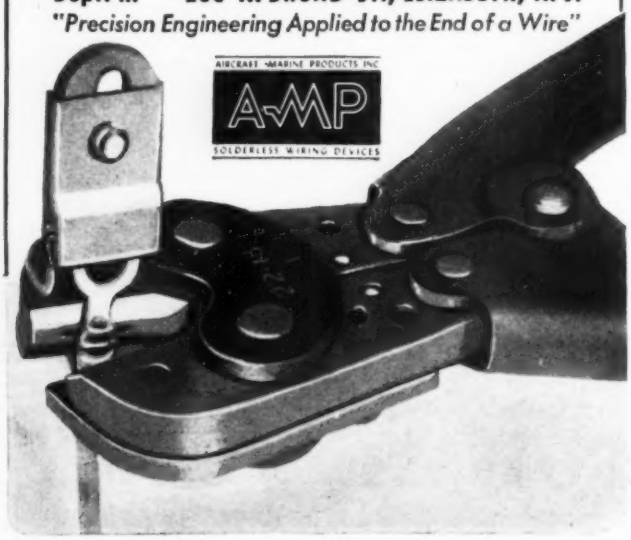
HERE is the perfect combination—the shorter, lighter, insulation support terminal assuring maximum electrical and mechanical characteristics, and its precision engineered hand tool which is so simple to operate that even unskilled women workers can be taught quickly to use it and obtain uniform high speed production.

The unique "Diamond Grip" design affords full protection for both the wire and insulation, and visual inspection of every finished connection. Here is a terminal and installation tool that give corrosion-resisting connections which meet the most strenuous service requirements.

THE AMP "HAND DIE" TOOL

1. The tool is self gauging—it is impossible to damage the insulation by squeezing the handles too tightly.
2. The insertion gauge automatically positions the terminal—making for production-line assembly speed.
3. Insulation crimping jaws are easily adjusted to accommodate various insulation diameters.
4. 15 to 1 leverage ratio makes for low hand-crimping pressure by operator.
5. Army and Navy wire sizes clearly marked on tool.
6. Tool is easily made left or right handed.

AIRCRAFT-MARINE PRODUCTS, INC.
Dept. R. 286 N. BROAD ST., ELIZABETH, N. J.
"Precision Engineering Applied to the End of a Wire"



Conservation of Critical Material

As the supply of critical material becomes more acute, directives have been forwarded to the Service Command Signal Officers making it mandatory that telephone allotments for all new military establishments are to be reduced approximately 25 percent. This directive will also apply to existing camps and posts which will result in the removal of certain equipment for use at new military establishments. Pertaining to ground forces, the major reduction in telephones will be accomplished by allotting telephones down to and including battalions, except where companies are functioning as a separate unit, and similarly the same procedure will apply to Army Air Force Units as applicable.

Heretofore, priority applications (Forms PD1A and PD200) pertaining to the procurement of material and equipment for telephone systems to be installed at military establishments have been required by the War Production Board from only independent telephone companies. As the Western Electric Co. is the manufacturing agency for the Bell System Companies, it has furnished telephone materials and equipment to the Bell Companies from its monthly allotments of critical materials. Hence, the Bell System Companies have not been required to make priority applications.

Effective as of August 1, 1942, all commercial telephone companies are required to submit priority applications. In order to expedite procurement, one copy of Forms PD1A and PD200 must be forwarded to the Service Command Signal Officer by the commercial telephone company involved. The Service Command Signal Officer will prepare a letter transmitting the application to the Chief Signal Officer for final review and approval. This letter will include a certificate as to the military necessity of all component parts of the telephone system involved and an explanation of the reduction of telephone equipment to that necessary to meet the absolute minimum requirements.

In order to simplify the furnishing of radio station equipment for Task Forces, arrangements are being made to supply miscellaneous material required in these installations in the form of kits. One kit which is being assembled will cover all the material required for the construction of rhombic antennae. Another kit will include all basic tools together with a small amount of bolts, nuts and screws required at the smaller station installations. This kit will be known as Tool Equipment TE-87. A third kit will be known as Tool Equipment TE-88, and will include a more elaborate lay-out of tools required at the main radio stations. This kit will include such items as: chain hoist, electric drills, and the more special tools needed for complete overhaul of radio transmitters, power units, and radio receivers.

Your opportunity to learn!
Join the U. S. Army
Signal Corps!

COMMUNICATIONS
. . . directing arm of combat

"Get the message through!" That's the tradition of the men who wear this insignia. Of the 18,000 Bell System people now in the armed forces, nearly 4,500 are with the Signal Corps. Young men can serve their country and obtain specialized training in communications in this great branch of the Army.

...and Western Electric equipment goes to every battle front

Army planes fly and fight with Western Electric radio command sets, which keep the planes of a squadron in contact with each other and with the ground forces.

Wherever American soldiers fight in tanks, they get their orders over Western Electric radio sets—vital in coordinating today's mechanized warfare.

Observers report front-line action to Army commanders over Western Electric field telephones, field wire, field switchboards.

A major source for this specialized equipment is Western Electric—for 60 years manufacturer for the Bell System—one industry with over 70,000 skilled men and women dedicated to *"keep 'em in contact."*

Western Electric

ARSENAL OF COMMUNICATIONS

ARMY E NAVY

(*Continued from page* 216)
ing photographic developing and printing facilities for publicity, produced under the supervision of the commanding officer of the post.

The custodial responsibilities of the Signal Corps' photographic division are centered in the still pictures distribution branch, which has charge of the celebrated pictorial files of the Signal Corps, containing thousands of historic photographs of the Civil War—the famous Brady collection—and of subsequent military activities of the United States Army. Some 156,000 negatives are on file, and about 35,000 are current. To this great collection, the negatives being made by Signal Corps' photographers wherever America's armies are at work today will ultimately be added.

Close co-operation with the United Nations Film Committee, especially with the British photographic services, has resulted in the addition of a great many foreign training films to the Signal Corps' stocks. In return, American films are being made available to others of the United Nations, sound tracks in the appropriate languages being added when necessary.

Through the Army Pictorial Service the Signal Corps thus serves as a teacher, a historian, and an ambassador for the Army. This survey may have suggested the broad scope of its activities, and we may expect to see them grow still greater as the demands of warfare require. Throughout, however, it is assured that the photographic workers of the Corps can be counted on to do their full part in the task of getting the message through, whether that message be instructions to a new recruit or the vivid record of heroic action on the battlefield.

• • • — • —

Army Signal Service
(*Continued from page* 122)

kinds of weather could this be accomplished.

Because of a threat on the rear area, Lake Charles, it became necessary during the maneuvers to shift the entire rear area to the west. The magnitude of such an undertaking is very difficult to realize. It meant the moving of all large repair depots, repair facilities, and many troops a distance of approximately sixty miles. At the same time it was necessary to maintain communications. The entire move was made with a minimum of confusion, and communications at no time were seriously disrupted.

To show how commercial communications were used to the utmost, it might be well to cite an instance which occurred on the last day of the maneuvers. Troops of the Third Army had been quite successful in pushing back the troops of the Second Army. As Third Army troops progressed farther north, existing wire facilities became scarcer, and there was not sufficient time to install new facilities. One corps was in a particularly difficult position where it was practically impossible to furnish communication. Along the route being followed by this corps was one telephone line, a party wire having many rural subscribers. When the need for this circuit was explained to the telephone company, they agreed that they would turn their complete resources over to the Army. Their readiness to help is a good example of cooperation. Fortunately, the maneuvers ended before it was necessary to utilize this line.

From these highlights of how the Signal Corps gets the message through during a great series of maneuvers involving the activities of hundreds of thousands of men, a reasonably comprehensive picture of the task of establishing Army signal service in the field can be secured. The utilization of all possible means of doing the work, the co-ordination of men, machines, and words, and the determination to see that the message gets through—all find in maneuvers an expression anticipating that which war itself demands.

• • • — • —

The Signal Corps
Needs Men.
Join Now!

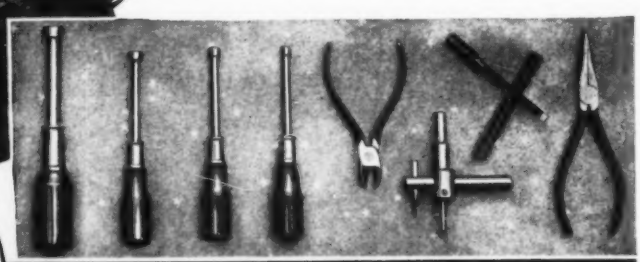
Communications Must Be Kept

The intricate maze of modern radio equipment needs frequent servicing . . . and good tools to speed the work. Spintite, the wrench that works like a screw driver is on the job from assembly lines to air bases . . . on ship and ashore.

Originally developed by Stevens Walden, Spintite features drilled shank, non-slip handle, precision machining . . . a tool to do a better job.

To speed your production or to facilitate servicing, we offer these wrenches produced by a plant with over 36 years experience in building good tools. Send for catalog showing complete range.

T51 Set at left, is popular for quick repairs. Chuck type handle, 7 Spintites with sockets ranging from 3/16" to 1/2", Reamawl, three screw drivers in various sizes. All in compact leatherette roll.



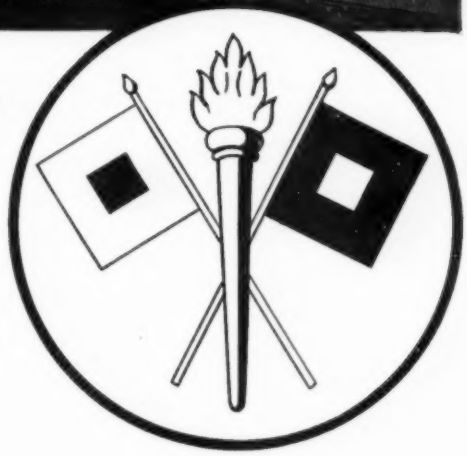
STEVENS WALDEN WORCESTER WRENCHES TOOLS & BOXES

STEVENS WALDEN, INC.
467 SHREWSBURY STREET
WORCESTER, MASSACHUSETTS, U. S. A.

We're Proud That We Can Help

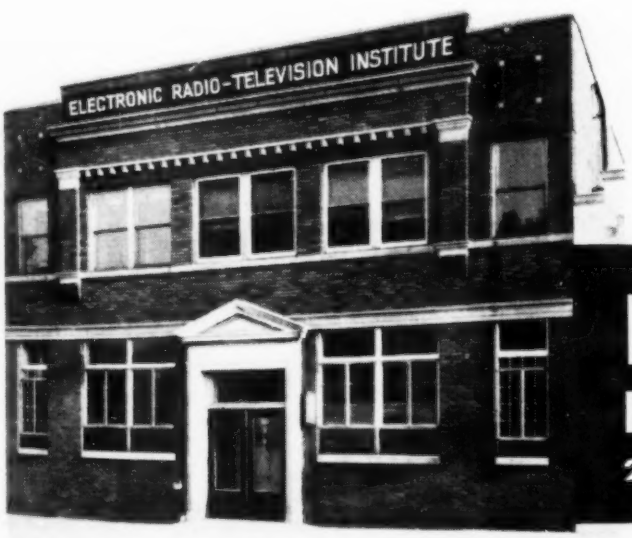
Signal Corps radio operators study code at Electronic Radio-Television school.

They know how to use their equipment —and how to build it.



TO the voice and the ears of a fighting army, our congratulations. From the command to the personnel, the United States Army Signal Corps is today a smooth functioning organization . . . trained, equipped for Victory.

That we have been able to help is an honor. For years we trained civilians for radio work. Today, in addition, we're helping train the Signal Corps. We're proud of our job . . . and we'll be prouder still when their training turns to peacetime occupation. For wars do not last forever. Radio will.



ELECTRONIC
Radio Television Inst.
2055 HARNEY STREET OMAHA, NEBR.

Forecast by Billy Mitchell

Training & Operations Group
Training Division.
May 6th, 1920.

Memorandum for the Executive.

1. Due to a shortage of personnel and to the uncertainty of wireless telephony and telegraphy, radio development has, I believe, been hesitating and uncertain during the past eight months. Accordingly, with a view to quickening the development of this all-important branch of the Air Service, I am submitting a policy for approval based upon the requirements of this group, and recommend that those responsible for the procurement, installation and functioning of this policy be urged to approximate the ideal laid down at the earliest possible moment. Our responsibilities in this respect and those of the Signal Corps are fully appreciated, but it is felt that a clear enunciation of our wishes in this matter will more quickly produce the desired results and bring us abreast of the latest development in radio the world over.

RADIO POLICY

2. The Director of Air Service announces that for the best functioning of airplanes, he requires the following of radio in order of importance and wishes it developed, put into production, installed in the Air Service and operated at the very earliest moment consistent with appropriations and the development of the science.

(a) The installation at all strategical points in the United States of ground stations on permanent airdromes, capable of talking by telephone to planes not less than 200 miles distant, and by radio, Morse Code, not less than 400 miles distant, the prime function of this outfit to be direction finding and the secondary actual communication for the purpose of ascertaining weather conditions and other information.

(b) The installation and operation in as many planes as practicable of a receiving instrument capable of being used with any ground station, including that mentioned in paragraph (a), this instrument to be of the smallest weight possible consistent with reliability and simplicity.

(c) The installation and operation in all multi-engine planes, four per squadron two-seater planes, and three per squadron single-seater planes, a light sending telephone set with radius of not less than three miles telephone, and six miles radio, Morse code.

(d) Installation and operation of a localizer for use on planes to effect safe landing upon arriving at an airdrome in a fog.

(e) The installation of a combined receiving apparatus and Morse ground sets at (a) all Air Service activities, (b) all municipal landing fields.

(f) The installation and operation of a sending apparatus for all municipal landing fields, with radius of action, telephone 50 miles and radio, Morse code, 100 miles.

(g) Development of a portable sending instrument from troops on the ground to airplanes in the air, combined telephone and radio Morse, radius of action telephone 3 miles in all directions, radio, Morse, 6 miles in all directions.

(h) The installation and operation of antenna for airplanes, internally fixed in the wings.

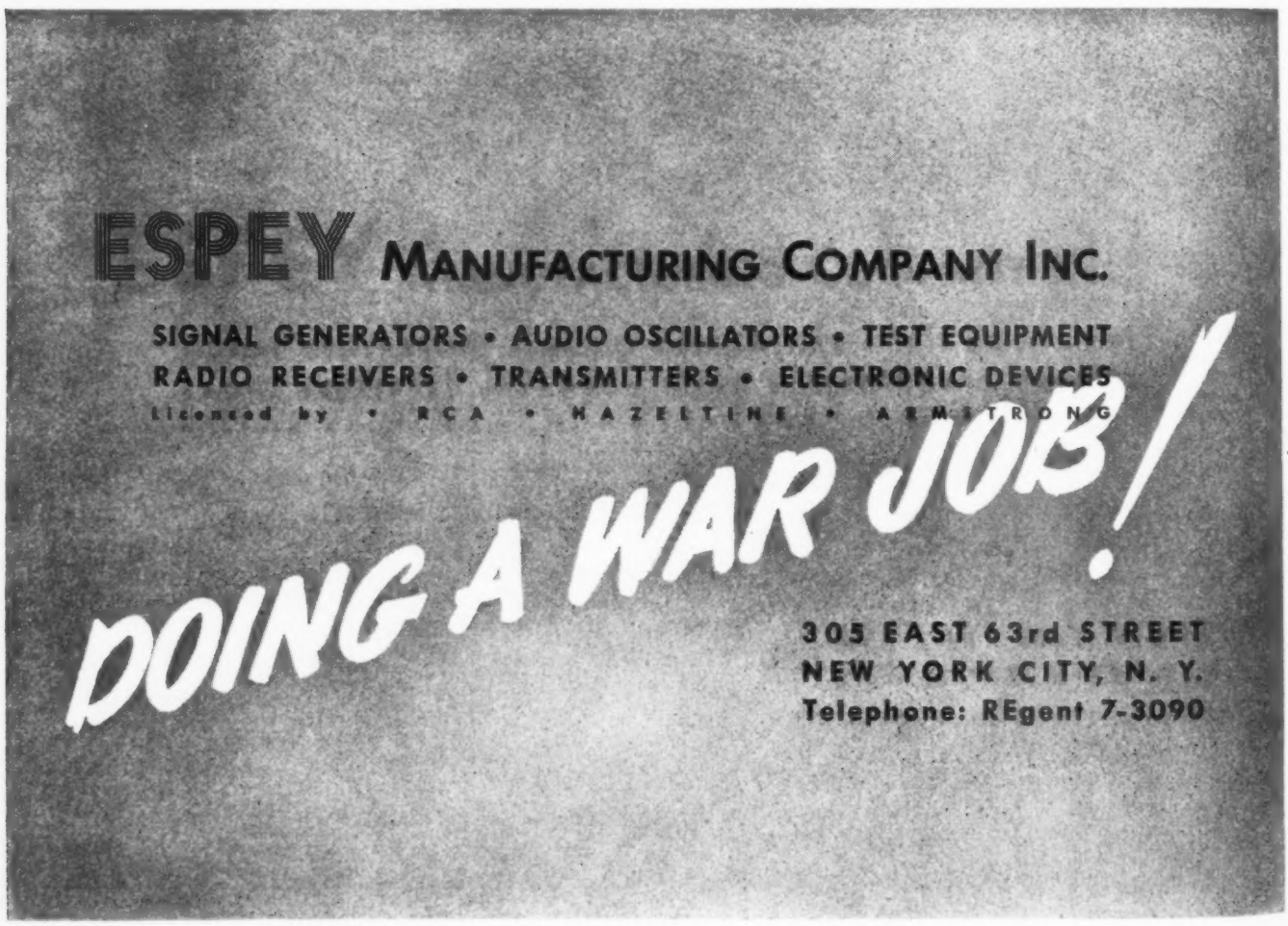
(i) The installation and operation of radio equipment for the control of other airplanes in flight, both from the ground and the air, irrespective of the presence of the pilot in the plane controlled.

(j) Transmission of power by radio.

WILLIAM MITCHELL,
Brigadier General, U.S.A.
Chief, Training and Operations Group.

It is interesting to note the accuracy in forecasting by Gen. Wm. Mitchell. All of the items, with the exception of "(j)" have since become a reality.—EDITOR.

This letter was found recently in the files of the late Aviation Authority.


ESPEY MANUFACTURING COMPANY INC.
SIGNAL GENERATORS • AUDIO OSCILLATORS • TEST EQUIPMENT
RADIO RECEIVERS • TRANSMITTERS • ELECTRONIC DEVICES
Licensed by • RCA • HAZELTINE • ARMSTRONG
DOING A WAR JOB!
305 EAST 63rd STREET
NEW YORK CITY, N. Y.
Telephone: REgent 7-3090

This is...

NOT AN ADVERTISEMENT

But.... **A TRIBUTE**

to the U. S. Signal Corps in appreciation of its interest in the Radio Industry. We pride ourselves on being in a position to fully cooperate with this efficient organization. Our wholehearted efforts are enlisted in the manufacture of equipment essential to the prosecution of the war and the advancement of signal operations.

WELLS-GARDNER & CO.

CHICAGO • ILLINOIS

Opportunity
(*Continued from page* 133)

he get it free, while he is learning, but he is also actually paid a salary as a civil service employee provided he enrolls for a full-time course. And after he graduates, he gets a job and a raise in pay. *And that job is vital to the winning of the war.*

How long does the course take?

Well, the full course takes from three to nine months, depending on the previous training of the student. There are a lot of folks who can complete it in three months. There should be a large number of applicants who have had some of the preliminary technical education so that they can immediately be put in the more advanced classes.

Others need not take the advanced courses, because many men are required for radio maintenance work on the less complicated sets. They will take only the courses which will fit them for the work they are to do and thus they will get on the job much more quickly than those who need the full course. And when they start on full-time productive work they get pay prescribed by the Civil Service Commission.

And there is another beautiful thing about this whole proposition. There are a lot of folks with minor physical defects who want to do something to help win the war. Many of them would like to fight—but they are handicapped and can't enter the armed forces. Here is their opportunity. For they can put a nail in Hitler's coffin, which will be just as effective as a bullet in a Nazi—by fixing a radio so it will safely take a bomber on its mission to destroy Berlin.

A man does not have to be physically perfect to repair a radio or to do even more advanced technical work. All that is necessary is that he be able to work regularly at what he would learn in one of these schools, and not be a hazard to himself or his fellow workers.

All students will be placed in the specific course in these schools where their previous training permits them to take up training.

Many of the men who are physically able will be offered an opportunity to enlist and enter Military service when they finish their education. Some will have the opportunity to enter Officers' Training School and train for a commission. And those who are not able to pass the physical requirements or who are over age or for other reasons cannot get into the Armed services, will still have their place in the sun. For they can slap a Jap—by keeping tanks operating, keeping planes in the air, protecting our shore lines, handling messages for the Armed Forces—dozens of services just as important to the winning of the war as donning a uniform.

Where shall I work after I satisfactorily complete my course?

The Signal Corps has nearly a hundred maintenance depots in every part of the country. As a civilian you will probably be assigned to one of these.

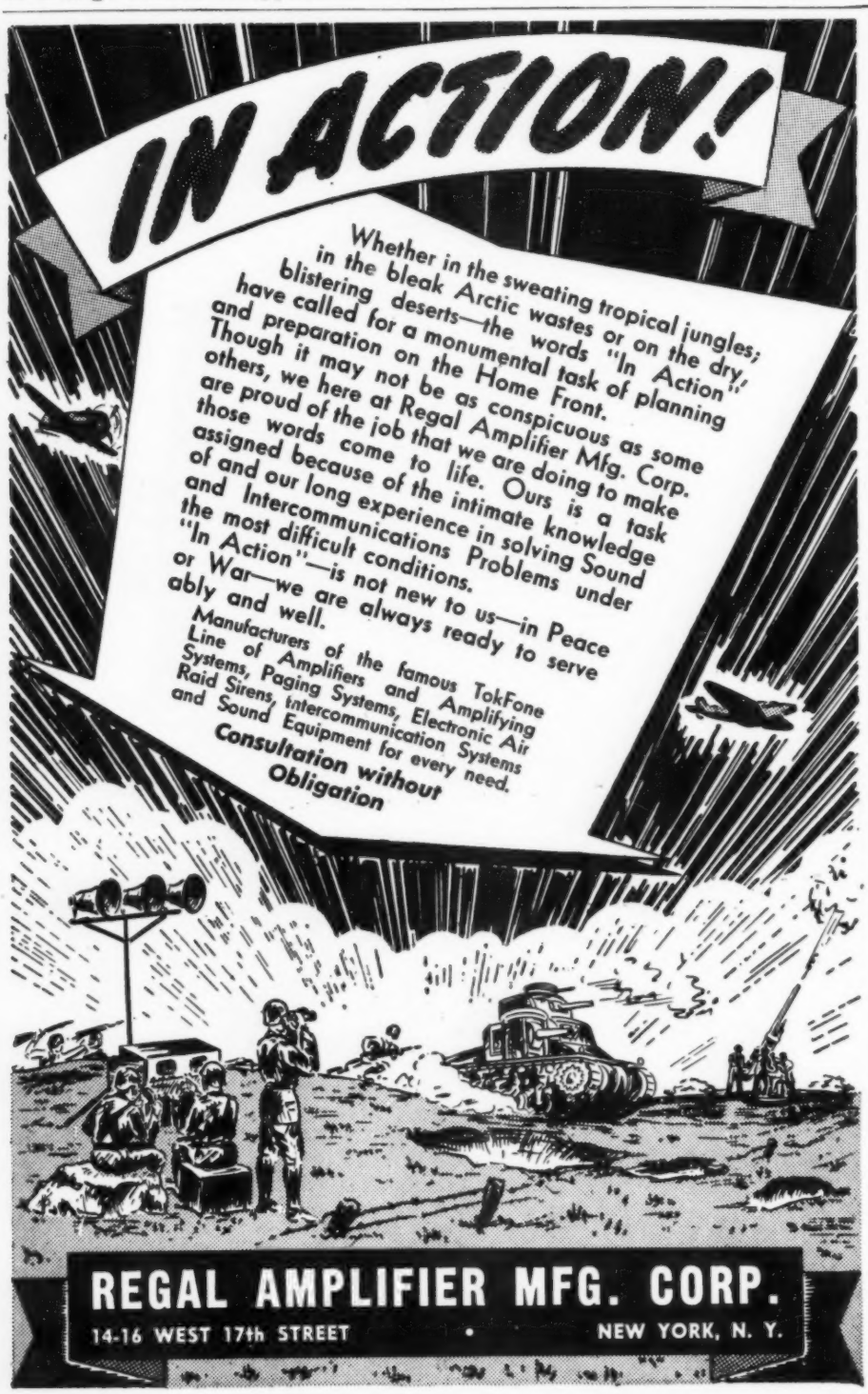
If you go into the Military service, you may get to Europe, Asia, Australia—who can tell! Wherever American troops are—there is the Signal Corps.

Again, this is one of the greatest educational opportunities ever offered. Any office of the United States Employment Service, any recruiting office of the Army, any office of the United States Civil Service, almost any school superintendent, or principal or teacher, can tell you where to go to get full information.

This sounds like an advertisement, doesn't it? It is. But it isn't trying to sell a thing but VICTORY. It is an advertisement to get people to help protect our own shores, to get people to help win the war by taking responsible parts in the Signal Corps' operation of that great art of communications without which our armies would cease to function.

. . . — . —

Enlist in the
U. S. Army
Signal Corps.


IN ACTION!
Whether in the sweating tropical jungles; in the bleak Arctic wastes or on the dry, blistering deserts—the words "In Action" have called for a monumental task of planning and preparation on the Home Front.
Though it may not be as conspicuous as some others, we here at Regal Amplifier Mfg. Corp. are proud of the job that we are doing to make those words come to life. Ours is a task assigned because of the intimate knowledge of and our long experience in solving Sound and Intercommunications Problems under the most difficult conditions.
"In Action"—is not new to us—in Peace or War—we are always ready to serve ably and well.
Manufacturers of the famous TokFone Line of Amplifiers and Amplifying Systems, Paging Systems, Electronic Air Raid Sirens, Intercommunication Systems and Sound Equipment for every need.
Consultation without Obligation
REGAL AMPLIFIER MFG. CORP.
14-16 WEST 17th STREET • NEW YORK, N. Y.

CONTINENTAL RADIO & TELEVISION CORPORATION

3800 West Cortland Street

CHICAGO, U. S. A.

In peace times, one of the world's largest manufacturers of civilian radios . . . today, the complete facilities of our two large modern plants . . . under the supervision of a competent designing and engineering staff . . . is engaged exclusively in the production of Radio Communications Equipment for our Armed Services.

MANUFACTURERS OF

Admiral RADIOS

AMERICA'S SMART SET

New Signal Corps
(*Continued from page 47*)

which underlies all Signal Corps' activity derives not only from the rapidity of progress in the art of communication, but also from the unique position the Signal Corps occupies in relation to the other arms and services. It is in constant contact with the latest developments and techniques of long-range bombing, dive-bombing, aircraft pursuit, anti-aircraft fire, tank warfare, commando methods, and all the other ways in which our forces are preparing to strike. The new rifle for the infantry, improved vehicular equipment for the Armored Force, and recently created devices for the cavalry, all are studied by the Signal Corps.

As advances are made in the matériel and methods of the other arms and services, there must be simultaneous advancement in the signal equipment and methods that control their use. The Signal Corps, therefore, could not stand still even if it should want to. It must constantly seek and devise, as part of its normal routine, new instruments and practices to make the Army a more powerful striking force.

Each arm and service, of course, has its separate mission, and its interest in and need for communication varies according to its specific task. However, all communications of every arm and service must be integrated into a unified whole, for no one arm or service can operate effectively all alone.

The planes in the air and the tanks on the ground must work together with the same fine coordination as the right and left hands of an expert boxer. It is a Signal Corps' function to insure such integration to the maximum possible extent, so that each element of the Army can communicate simply, clearly, quickly, both within itself and with all other elements.

To defeat the Axis we must not only outman, outgun, outfly it; we must also out-signal it. The Signal Corps is fully aware of that responsibility. That is why it has secured the assistance of the country's outstanding genius in research, development, and manufacturing; why it has established such tremendous schools to train men in the advanced phases of electronics as well as the more conventional fields; and why its vast laboratories, in close collaboration with civilian laboratories, are daily conquering heretofore insurmountable technical obstacles.

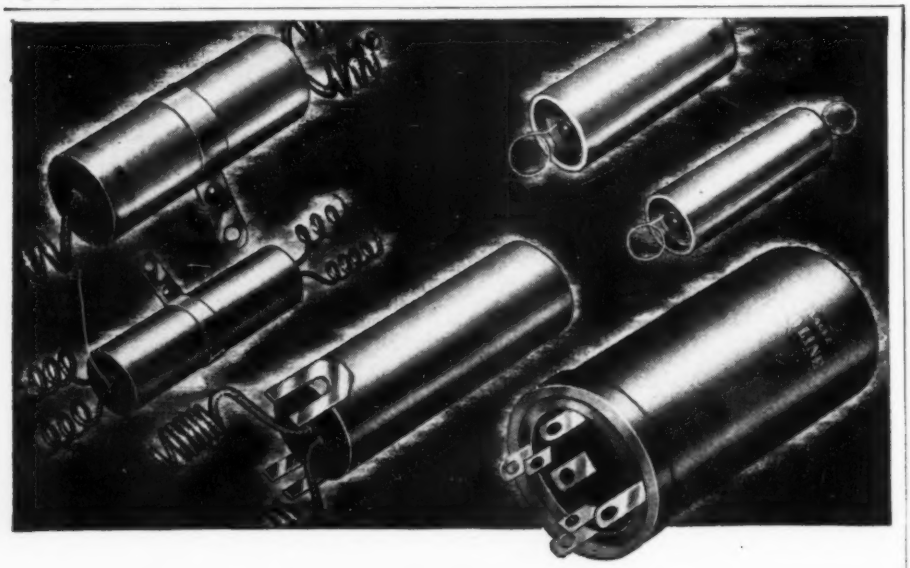
The work that the Signal Corps is doing today, although focused exclusively on the winning of this war, will have a profound effect on the lives of all of us when peace comes and the dramatic technical strides that have been made can be revealed and dedicated to the cause of lasting peace.

The war began in the Age of Electricity. It will end, even if it should end tomorrow, in the Age of Electronics. From the laboratories of the Signal Corps will pour, already fully tested, innumerable new technical principles, many of them so radical as to confound the imagination. They will be merely waiting to be applied directly and on a huge scale, to the peace-time phases of existence. They will not have long to wait, for among the men the Signal Corps has trained will inevitably be found the key personnel that will apply them in the field of commercial enterprise, and in the achievement of a fuller, freer life.

. . . — . —

"WHERE SKILL AND COURAGE COUNT"

U. S. Army Signal Corps



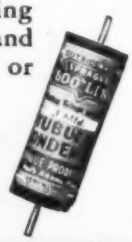
HERE'S THE ANSWER

TO ALMOST ANY CONDENSER REPLACEMENT PROBLEM

Replacements of dry or wet electrolytic condensers, low voltage or high voltage, single units or dual or triple combinations—Sprague Atom Midget Drys and Type EL Prong-Base Drys handle them all. They take up less space, they cost less, and they're easy to mount. What's more they're *not* substitutes. They're better and more dependable than the old-style large condensers of equal rating that they replace. Your Sprague jobber has them—and you'll find they give you just what you need for 90% or more of the electrolytic replacements you are called upon to make.

SPRAGUE PRODUCTS CO.
North Adams, Mass.

Use famous Sprague TC Tubulars for every by-pass condenser need. "Not a failure in a million."



SPRAGUE

ATOM MIDGET DRY ELECTROLYTICS • TYPE EL PRONG BASE DRY ELECTROLYTICS

"Position 'X' evacuated! TRAINED MEN advance now!"

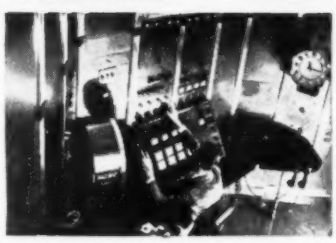
GET READY FOR YOUR OPPORTUNITY. . . . It's HERE! Radio technicians are needed everywhere; afield in action, and at home in industry! Trained men are needed in the Army, Navy and Air and Signal Corps, Government Defense Service and Civilian fields. Now, in answer to repeated demands for Trained Radio Technicians, National Schools has extended its famous Shop Methods so you can qualify right at home. You can quickly prepare to be of greatest service to your Country and yourself. Yes, right at home, in your spare time. National's time-tested plan of Home Training will definitely establish you, in a short time, so you can hold a good job in this fascinating field. Furthermore, you become equipped for an even bigger career in the years of reconstruction after the war. Learn Radio in all its practical branches by National's proven methods.

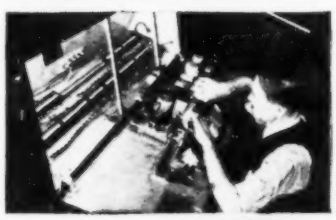
(Draft Age Men: TRAIN Before Entering Service)

RADIO NEEDS YOU IN MANY FIELDS

QUALIFY FOR THESE TOP PAY JOBS

Radio Expert
Broadcasting
Aircraft—Marine
Indust. Electronics
Studio Technician
U. S. Govt. Service
Re-Manufacture





NATIONAL GRADUATES WIN GOOD POSITIONS

Thousands of graduates of National Schools are employed throughout America and in many parts of the World—strong testimonials of successful Training.

HELPED IN SERVICE

Since joining the Army my work has been both Theatre and Sound work, thanks to National Training. This is most interesting work. Radio training has helped me a great deal.

Pvt. F. M. Cary
Warren, Wyo.

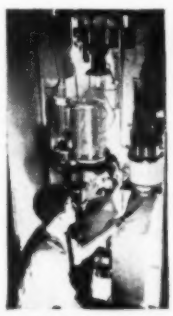
WITH BIG FIRM

Am employed at General Electric plant in Bridgeport as inspector on Radio for Army and Navy. I owe a great deal of my success to National Training. Wish I could see your instructors and tell them of my good luck National has brought to me.

Chas. Plunkett
Danbury, Conn.

TESTED HOME TRAINING BY PROVED SHOP-FIELD METHOD

Unlike any other course of Home Training, National Schools bring you a personalized, instructor-to-student series of assignments — an actual extension of the same study and training you would receive if you attended the School in person. National's Victory Training Plan speeds up your radio progress right from the start, yet omits absolutely nothing vital to your preparation for entering Radio in any of its branches. Squarely behind your Home Training are the modern, completely-equipped training shops of National Schools where we develop and prove every shop method assignment sent to you. Every phase of your training is personally supervised by an established faculty of practical, experienced instructors and engineers who have the knack of imparting knowledge, ways and means of guiding you, so that with each succeeding lesson you become more and more enthusiastic.



FASCINATING WAY TO LEARN RADIO

You learn by the most practical shop-laboratory methods —using the same instructions and technique as employed in radio shops, studios, production plants and U. S. Govt. services. Your training assignments grow more fascinating as you progress, step by step, through fundamentals of radio, construction, layouts, operating routine, etc. Amazing as it may seem, you acquire this useful workable training AT HOME. Qualify for good pay job with assured success not only in war-time but later after the war ends when Radio will continue its vast expansion.

SPECIAL FREE OFFER

Mail coupon on penny postal or in envelope and you will receive FREE Complimentary Specimen Lesson and Big Opportunity Book.

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HOME TRAINING HEADQUARTERS
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ESTABLISHED 1905

MAIL OPPORTUNITY COUPON FOR QUICK ACTION

National Schools, Dept. 11-RN **(Mail in envelope or paste on penny postal)**
4000 So. Figueroa, Los Angeles, Calif.

Mail me FREE, without obligation, one Lesson and Opportunity Book, with full details about how I CAN become a RADIO Technician.

NAME _____ AGE _____

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USE THIS COUPON

FREE LESSON & OPPORTUNITY BOOK

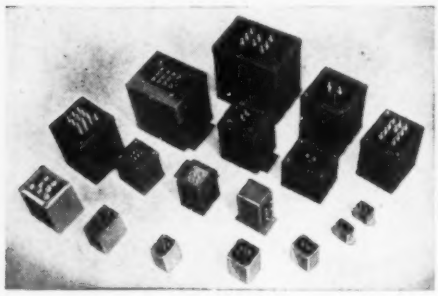
More than 37,000 Graduates

MEN WANTED Ages 16-50

In Radio, age is not a factor. Training is the main requirement.

Custom Made Transformers from ACME STANDARD PARTS

Are transformers a part of your manufacturing problem? Then get in touch with Acme Electric and free your mind and your plant of transformer production worries. We're transformer specialists. Thousands of special designs have been produced in Acme's three plants for hundreds of transformer users. We offer War Products Manufacturers all facilities and a complete organization to produce quickly to high quality standards. Your special transformers can probably be produced in jig-quick time by adapting and utilizing tools and dies from the hundreds in stock ready to work for you.

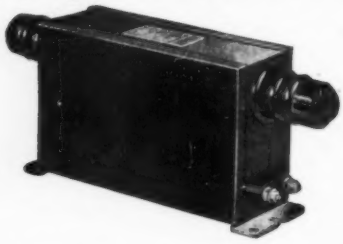


Audio transformers, Driver transformers, Interstage transformers, Reactors, Input transformers, Power transformers, Plate Supply transformers, Filament and Rectifier transformers produced by Acme for prime contractors.

Here's a Design

Here's an Acme air-cooled design that can be adapted to a wide range of applications. Maybe the special characteristics of the transformers you need can utilize the tools that build this design.

This Might Be What You Need



This compound-filled, high voltage secondary, transformer is only one of a series of designs originally built for Luminous Tube sign and Cold Cathode lighting applications. Do your needs compare with the serviceability of such applications? Write Acme today.

THE ACME ELECTRIC & MFG. CO.
31 WATER STREET CUBA, NEW YORK

Acme ACME Electric
TRANSFORMERS

Yanks Set Up Communications on Guadalcanal

Acme Photo

U. S. Marines set up emergency outfits for contact with advancing patrol forces and with ships of the fleet during early phase of offensive operations.

U. S. Amphibious Tanks land on Guadalcanal, Solomon Islands

Acme Photo

Here come the Marines! This amphibious tractor lands on a beach in the Solomon Islands. Signal Corps Equipment keeps them in radio contact.

Service and Equipment for The Signal Corps have helped to win this honor for the men and women of PHILCO

WITH a background of 50 years of experience and over 12 years of continuous leadership in the radio industry, the Philco laboratories and assembly lines are now devoted 100% to research and production for our armed forces.

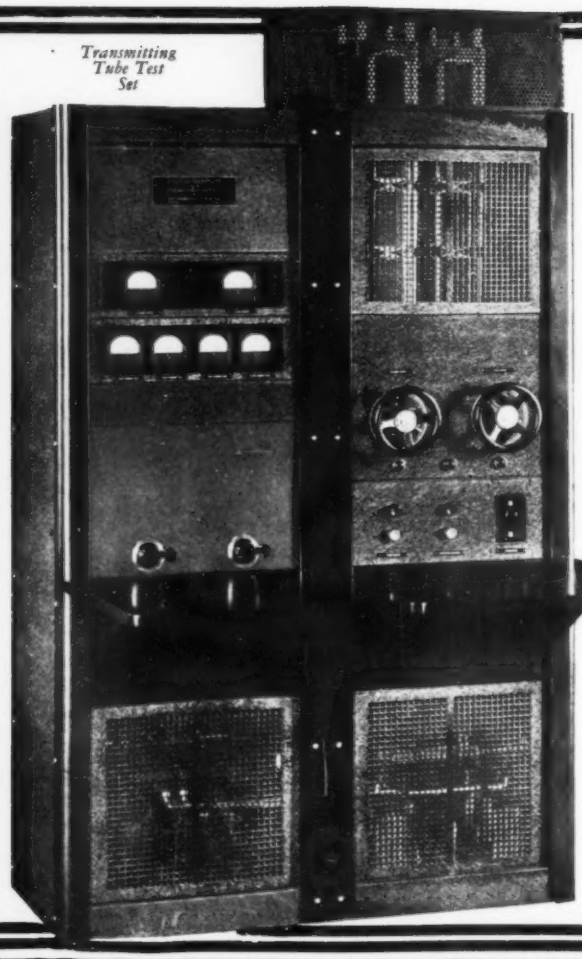
A major portion of that work is for the Signal Corps, much of it of a secret nature. Laboratories are at work on vital war assignments in the field of electronic research. Production lines are engaged in the manufacture of intricate communications equipment and precision radios for tanks and airplanes. A training school, planned and manned by Philco engineering and service personnel, is schooling thousands of men in the operation and maintenance of Signal Corps equipment.

In addition, Philco is producing artillery fuzes, shells and electric storage batteries for the Army, Navy and war production plants. Thus its war production activities touch every branch of our armed services, on land, at sea and in the air.

For this, the Army and the Navy have seen fit to honor the men and women of Philco with the new, joint Army-Navy Production Award. The "E" flag flies above the Philco plants at Philadelphia, Pa., Sandusky, Ohio, and Trenton, N.J. And every Philco employee is privileged to wear the official Army-Navy "E" insignia as a badge of honor and as an incentive to all-out effort until Victory is won.

PHILCO CORPORATION

PHILADELPHIA, PA. SANDUSKY, OHIO TRENTON, N. J.



The job we are doing

is the one we're best fitted to do!

The engineering and production skills that before the war created the outstanding, high quality Philharmonic Phonograph-Radio, are today entirely devoted to our part in arming America for victory.

Today we are doing the job for which peacetime skills prepared us perfectly—the precision manufacture of electronic equipment in both large and small units for the use of our Army and Navy, and some of the country's largest industrial concerns meeting their needs.

Equipment manufactured by us, to the most exacting specifications, has included:

- Crystal Test Oscillators
- Multivibrators
- Modulator-Amplifier Units
- Special Resistance Capacity Oscillators
- Amplifier Type Vacuum Tube Voltmeters
- Transmitting Tube Test Sets
- Peak Emission Test Sets
- Filament Current Grid Emission and Mu Test Sets
- Oscillation Seasoning Sets
- Ionization Gauge Amplifiers
- Video Amplifiers
- Regulated Power Supply Units
- Power Amplifiers for Small Motor Controls
- Special Transmitters and Receivers
- Wide Range Cathode Ray Oscilloscopes

We will be glad to discuss your requirements with you

PHILHARMONIC RADIO CORPORATION

218 William Street · New York City

PHONOGRAPH COMBINATIONS ★ HOME RECORDERS

SAVE additional 10% on complete radio-phonograph combinations or home recording assemblies

RECORDER ASSEMBLY NO. 864

(Includes)

No. 880 Hepplewhite Cabinet	$ 34.95
No. 365 Home Recording Chassis	29.95
No. 240 G. I. 2 Speed Recorder	24.95
No. 19 Crystal Microphone	2.50
Total	$ 92.35
Special November Net Price	**$83.11**

SPECIALS

Multi-purpose aerial kits	$ 1.49
3-tube phonograph amplifiers	8.97
New Products record changer	19.97
10-in. Permanent magnet speaker	5.97

RECORDER ASSEMBLY NO. 986

(Includes)

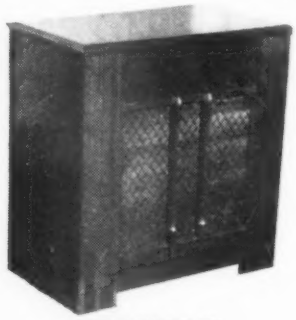
No. 890 Georgian Cabinet	$ 49.95
No. 285 Super Changer-Recorder	49.95
No. 366 Home Recording Chassis	32.95
No. 20 De Luxe Microphone	3.75
Total	$136.60
Special November Net Price	**$122.94**

(RADIO SERVICEMEN! *Refer to circular #642*)

PHONO ASSEMBLY NO. 682

(Includes)

No. 860 Moderne Cabinet	$ 19.95
No. 180 Super Record Changer	24.95
No. 320 Push-Pull Chassis	24.95
Total	$ 69.85
Special November Net Price	**$62.86**



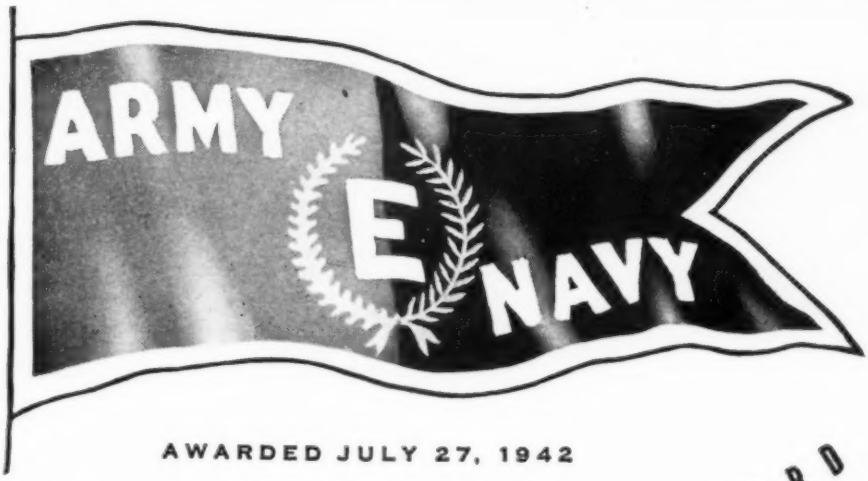
SPECIALS

Uncut Console radio cabinets	$ 9.97
Single Post record changer	12.45
Period combination radio cabinet	18.97
5-in. oval dynamic speakers	.99

Write Today for Complete circular of Radio Component Parts

MUTUAL RADIO PRODUCTS COMPANY • 1579 Milwaukee Avenue • Chicago, Ill.

THE ALCO PLANT WAS ON THE FIRST LIST OF 43 AWARDS FOR EXCELLENCE IN QUALITY AND QUANTITY OF WAR PRODUCTION



AWARDED JULY 27, 1942

ARMY-NAVY PRODUCTION AWARD

★ ★ ★ ★ ★ ★ ★

IN THE SHADOW of war-historic Lookout Mountain, within gun shot of America's bloodiest battlefield at Chickamauga, on soil hallowed by the best blood of North and South — there proudly flies the Army-Navy burgee.

Nearly a hundred years ago in the Mexican War of 1846, when Tennessee exceeded its quota by supplying 30,000 troops instead of 2,800, it earned, and has retained, its title as the "Volunteer State." Perhaps there is significance in the fact that this area was one of the first in the land to receive an Army-Navy combination award for excellence in quality and quantity of war production. A star is offered by the Army-Navy for every period of six months in which the record of high production is maintained.

Our employees, whose achievements in the production of ALSIMAG steatite ceramic insulation constitute the real glory of the award, wish to publicly record their determination to earn a Service Star every 180 days. This is not at all for our aggrandizement, but as evidence of a stern resolution: "That our brave fighting forces on the water, on the land, in the air or under the seas shall never suffer from the lack of what we can supply." That shall be our goal and our pledge. This is our slogan:

WHILE AMERICA IS AT WAR,
AMERICAN LAVA IS AT WORK

Excerpts from Acceptance of the joint Army-Navy Burgee by Paul J. Kruesi, President

★ ★ ★

AlSiMag

TRADE MARK REGISTERED U. S. PATENT OFFICE

AMERICAN LAVA CORPORATION

CHATTANOOGA, TENNESSEE

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★ ★ ★

BRITISH OFFICERS INSPECT SIGNAL CORPS INSTALLATIONS

Accompany General Olmstead Back from England for American Tour

BECAUSE of the crucial importance of coordinating the Signal systems of the British and American Armed Forces, the last month has witnessed an important series of conferences and visits by American and British Signal officers.

Maj. Gen. Dawson Olmstead, Chief Signal Officer of the United States Army, initiated this latest series of conferences with a visit to England. On his return he was accompanied by a delegation of British officers whom he had invited to inspect Signal Corps installations and factories manufacturing Signal Corps equipment in the United States.

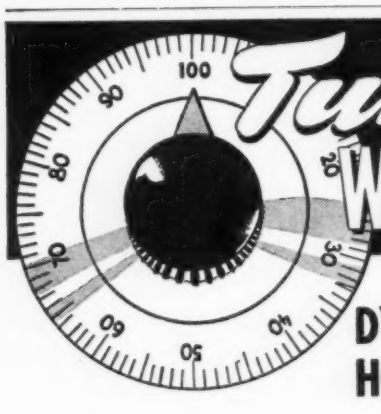
The visiting officers were Brigadier R. F. H. Nalder, O. B. E. Deputy Director of Signals at the British War Office; Capt. F. J. Wylie, Deputy Director of the Signals, British Admiralty, and Air Commodore O. G. W. G. Lywood, C. B. E., O. B. E., Director of Signals, British Air Ministry. They were accompanied by Col. W. D. J. Harries, British Army, Group Captain A. F. Lang, Royal Air Force, Capt. R. M. Dick, Royal Navy, and Squadron Leader F. Williams, Royal Air Force.

In their only interview for the benefit of the American press, the British officers stressed the importance of what they called the "radio war." They warned that German Signal equipment was "good" and that it was being produced in large quantities, but they added: "We believe we are one step ahead, and we hope to stay one step ahead."

The British officers, while stressing the importance of superior equipment such as has been turned out of American assembly lines, also emphasized the importance of the organization which uses that equipment.

"It isn't enough," Commodore Lywood said, speaking for the group, "to have equipment. One must have a highly trained organization. We hope we may be of assistance to your forces in this respect, since we have been at it longer. We want to learn all we can about American Signal organization and methods, in order that we may cooperate fully in developing complete collaboration between our two countries."

In addition to holding conferences on the standardization and coordination of communications procedure and equipment, the British officers inspected the United States Naval Academy and the United States Military Academy. They visited Signal Corps installations and factories at Baltimore, Philadelphia, Boston, New York City, Schenectady, Detroit, Wright Field, Fort Monmouth, Mitchel Field and Kearney.



DYNAMOTORS..FRACTIONAL HORSEPOWER D.C. MOTORS

Equipped, staffed and trained for volume production, *Alliance* facilities can and do meet highly critical requirements. Your precision specifications for large runs on dynamotors and band switch motors are made to order for *Alliance* production manufacturing.

Yesterday, the largest volume producer of fractional horsepower phonomotors, *Alliance* today is tuned for volume production to meet your critical specifications.

ALLIANCE MANUFACTURING COMPANY
ALLIANCE, OHIO

WAR MEMO: The aims behind the War Bond Payroll Savings Plan are worth repeating over and over:

1. To help pay the stupendous production costs of winning this war.

2. To siphon into production channels that portion of America's *current income* which would otherwise flood the Nation with inflationary cash.

3. To create individual backlogs of financial security for use during the industrial readjustment after the war.

4. To create a Nation-wide saving habit which will serve the interests of both Capital and Labor after the war.

Keep after that "10% of gross payroll goal"! Buy War Bonds to the limit yourself—encourage your employees to do likewise!

☆

EDITORIAL NOTE!

The letter appearing on page 222 was prepared by Lt. Col. Harold E. Hartney in 1920 and sent to Col. Pearson for approval. Col. Hartney is now Washington representative for RADIO NEWS.

☆

PASSING A TRIBUTE ALONG

IN GRATEFUL ACKNOWLEDGMENT **of the honor bestowed upon our organization . . . we take this opportunity to pay a well-earned tribute to the United States Signal Corps . . . the eyes and ears of our Armed Forces . . . on land . . . on sea and in the air.**

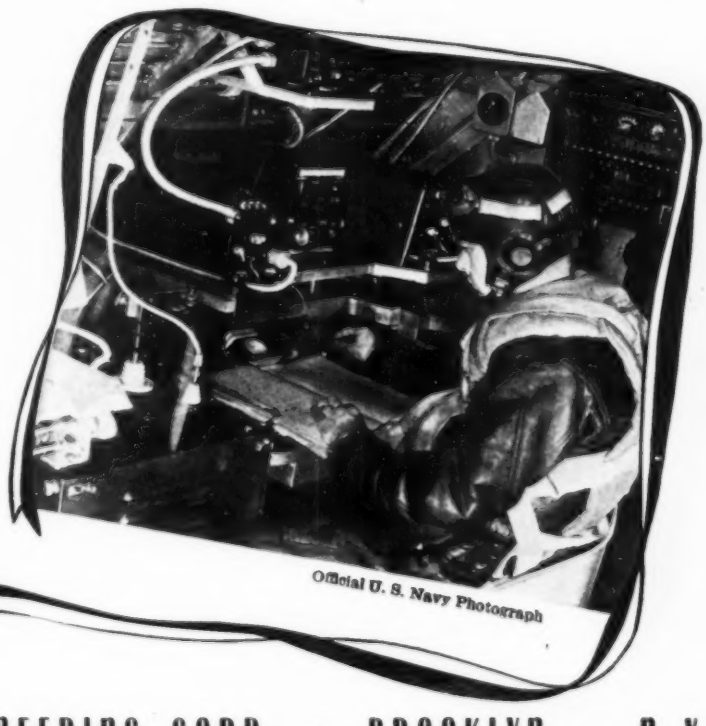
Upon the shoulders of these highly trained men rests the responsibility for vital communications . . . responsibility for successful coordination between highly specialized task forces . . . and the achievement of lightning attack.

WITH this highest of honors as a powerful incentive . . . the men and women of this organization in full appreciation of *their* grave responsibilities . . . will continue to apply their energies in steadily increasing measure to our great task.

The same high quality standards shall be maintained in the production of precision Electronic and Communications equipment for the Signal Corps . . . standards held in high esteem by the U. S. Signal Corps for 15 years . . . craftsmanship and dependability that has won equal recognition for our peacetime products.

Among the products manufactured by Federal to rigid specifications are the following:—Remote control tuning units, couplings, impact switches, microphones, switch boxes, interphone control units, jack boxes, flame-proof keys, jacks, plugs, sockets and components for pilot training equipment.

We, who supply the instruments for the Signal Corps take pleasure in passing along the tribute we have received, to the men who will use these instruments expertly.



Official U. S. Navy Photograph

FEDERAL

FEDERAL MANUFACTURING & ENGINEERING CORP. • BROOKLYN • N. Y.

Copy of letter received recently by the Chief Signal Officer from the British Air Commission.

ROYAL AIR FORCE DELEGATION
(British Air Commission)

August 3, 1942.

Maj. Gen. Dawson Olmstead,
Chief Signal Officer, Washington, D. C.

Dear General Olmstead:

I would like to thank you on behalf of myself and my fellow Directors of Signals, Brigadier Nalder and Captain Wylie, R. N., and the other members of the British party for the wonderful and, I believe, unique tour which we have just completed. We were fortunate indeed in having General Colton guide us and we are deeply appreciative of your kindness in this respect and trust that it has not too greatly interfered with the numerous activities of his high office. We should be most grateful if you could convey to him our appreciation of the splendid way he guided our tour and the very great additional value which we thereby gained.

We are also greatly indebted to the officers of your staff who at such short notice planned this magnificent tour and we should be most grateful if you would also convey to them our thanks.

All that we saw and learned on our various visits of inspection gave us a fuller understanding of both your problems and our own and, I assure you, will further assist in establishing closer collaboration between the Signal Services of our two countries, which we all agree is so essential to the successful prosecution of the war and which has been so well emphasized by you.

We would be glad if our thanks could also be passed to the other officers who looked after us all so well during the tour, namely, Maj. P. Ketterer, Lt. Comdr. E. B. Patterson, Capt. J. McCaw, Lt. A. K. McCleery and Mr. Frank Grubbs, the secretary.

Please accept our warmest appreciation.

Yours sincerely,
(Signed) O. G. LYWOOD, Air Commodore,
Director of Signals, Air Ministry, London.

MULTI-UNIT AEROPLANE HORNS

For SUPER-POWER highly efficient sound projection. Developed for installations where space is limited and weight factor small. STORMPROOF—guaranteed weatherproof even if completely immersed in water. Indoor and outdoor types 42" and 54" long are demountable, have heavy cast aluminum throat sections and suspension rings. Indoor types take 2 or 4 units, outdoor types 4 or 9 heavy units. Up to 3 mile ground projection capacity.

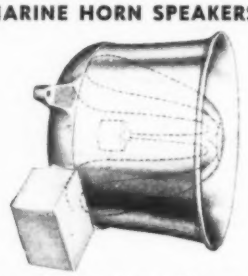
RE-ENTRANT TRUMPETS

RE-ENTRANT TRUMPETS, compact, of the double re-entrant type. Occupies small space but has long horn that delivers highly concentrated sound of greatest efficiency over long distances. Made of RACON Acoustic Material preventing resonant effects. Available in 6, 4½, 3½ and 3 foot air-column sizes.

RACON P. M. HORN UNITS

P.M. HORN UNITS, operating capacity 12-15 watts, peak 25 watts. Other P.M. units available, from "Baby" of 5 watts to "Bull" with an operating capacity of 50 watts. Efficiency of highest order obtainable because the finest magnetic material and steel is used.

MARINE HORN SPEAKERS



MARINE HORN SPEAKERS, re-entrant type, for Marine and general P-A applications. May be used as loudspeaker or as microphone. Approved by Bur. of Marine Inspection & Navigation, Dep't of Commer. All sizes available, 5 to 50 watts.

RACON Speakers, aboard U. S. Navy, Coast Guard, Maritime Commission Ships and Army Transports—in the frigid arctic and humid tropics—are efficiently doing their bit. RACON Products are playing a vital role in the Air Corps, on battle planes and blimps and at training camps. RACONS are used in Shipyards, submarine and destroyer bases—in Ordnance and industrial war-plants. Where sound distribution helps speed up production, and where lives depend upon Public Address Systems to carry orders clearly over the noise of battle or din of production lines, RACONS are the very finest available, are used for this important work, deliver more sound energy per watt input.

RACON is the world's largest manufacturer of all types of loud speakers, air-column horns and driving units. It is the only complete and matched line. There is a RACON for every conceivable purpose. Every RACON unit is tested before delivery. Built into each RACON are exclusive patented features such as Weatherproof, Stormproof and Acoustic Material. RACONS are not affected by hard use, climatic conditions such as heat or cold, aridness or humidity.

When planning your next sound installation, specify RACONS. Illustrated here are just a few different types.

RACON ELECTRIC CO. 52 EAST 19th ST. NEW YORK, N. Y.

Modern warfare depends on rapid movement and team work timed to the split second—on the ground—in the air—by day or night—in all weather.

To achieve this radio communications have become indispensable.

RADIO RECEPTOR salutes the SIGNAL CORPS on its splendid contribution to the triumph of our army and the inevitable victory of the UNITED NATIONS.

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MAXIMUM TESTING RANGE

WITH R. C. P.'s
NEW ELECTRONIC A. C.-D. C.
VACUUM TUBE VOLTMETER
OHMMETER AND
CAPACITYMETER

SPEEDS PRODUCTION TESTING AND SAVES VALUABLE ENGINEERING TIME IN LABORATORY

The new Radio City Product's Electronic Multitester Model 662 combines sensitivity with maximum utility and flexibility. Simple to read—simple to use, this instrument is suitable for either production line or accurate laboratory test purposes; in extensive use by U.S. Signal Corps.

• Here are a few of the outstanding features of this unusual instrument:

A genuine vacuum tube voltmeter on A.C. • A.C. Voltmeter measures signal and output voltages • Comprehensive capacity meter reads directly in microfarads—40,000,000 to 1 ratio • No danger of shock on low capacity measurements—no test leads to short—no resetting when changing ranges • Meter cannot be damaged by checking live resistors or by using a low range scale on high voltages • Voltmeter readings taken without affecting constants of circuit being checked • Matched pair multiplier resistors 1% accurate • Regulator tube and associated circuits control line voltage fluctuations • 2% accurate 4½" microammeter.

RANGES:

D. C. VACUUM TUBE VOLTMETER-DIRECT READING.
Sensitivity: Input Resistance — 160 megohms (high ranges); 16 megohms (low ranges).
Range: 0-6-30-150-600-1,500-6,000 volts.

A. C. VACUUM TUBE VOLTMETER-DIRECT READING.
Input capacity only .00005 mfd. Input resistance 160 megohms (high) and 16 megohms, (low).
Range: 0-3-6-30-150-600-1,500-6,000 volts.

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From the lowest scale division .1 ohm to 1,000 megohms.
Range: 0-1,000-10,000-100,000-1 megohm-10 megohms-100 megohms-1,000 megohms.

VACUUM TUBE CAPACITY METER-DIRECT READING.
Accurate measurements from .0000 5 to 2,000 mfd.
Range: 0-.001-.01-.1-1.-10-100-2,000 mfd.

Supplied in rugged, welded, crystalline gray finish steel case. Size: 9¾" x 9¼" x 7⅞". **$47.50**
Complete ready to operate.....
Model 662 V-7 with 8½" meter..... **$61.50**

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Meter sensitivity 2,500 ohms per volt. 5 D.C. ranges 0-1,000 volts. 4 A.C. ranges 0-1,000 volts. 4 D.C. ma. ranges 0-1,000. 4 ohmmeter ranges 0-10 megs. db. range minus 10 to 55. Meter 2% accurate.
In portable case, complete..... **$25.95**

Other instruments in the complete line of R.C.P. electronic and electrical test instruments described in catalog No. 126.

If you have an unusual problem calling for either laboratory or production line test instruments, our engineers will be glad to cooperate in finding the most efficient and economical solution.

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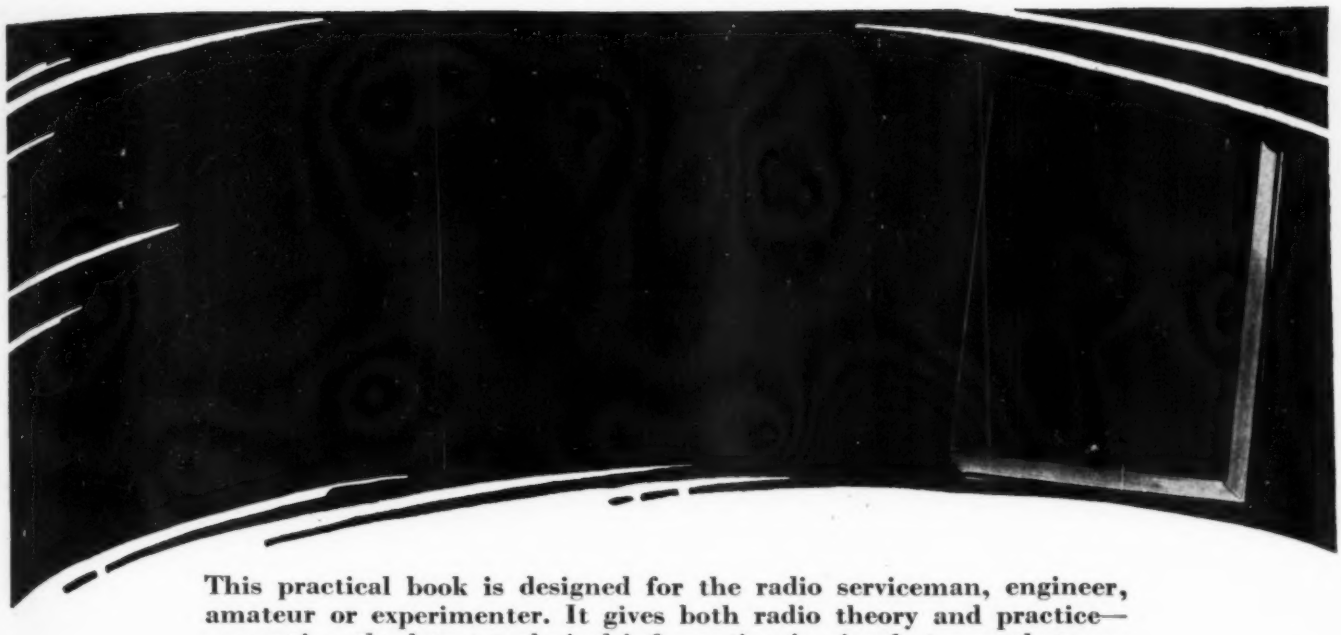
MANUFACTURERS OF QUALITY — ELECTRONIC LIMIT BRIDGES — VACUUM TUBE VOLTMETERS — VOLT-OHM-MILLIAMMETERS
SIGNAL GENERATORS — ANALYZER UNITS — TUBE TESTERS — MULTITESTERS — APPLIANCE TESTERS.



This practical book is designed for the radio serviceman, engineer, amateur or experimenter. It gives both radio theory and practice—presenting the latest technical information in simple terms that you can easily apply to everyday problems. Note the table of contents below—

TABLE OF CONTENTS

1. LOUD SPEAKERS AND THEIR USE
Written by outstanding experts in the design and application of loud speakers. Covers the acoustical properties of various designs. Tells in detail how loud speakers may be selected and installed for greatest economy and best performance. New information . . . never before published.

2. SUPERHETERODYNE FIRST DETECTORS AND OSCILLATORS
The heart of a superheterodyne is its first detector. Many receiver problems involve more than just voltmeter readings. This chapter makes servicing easier by presenting the basic principles governing first detectors and oscillators. It covers *all* modern conversion systems.

3. HALF-WAVE AND VOLTAGE DOUBLER POWER SUPPLIES
Explaining the power supply design in AC-DC and series heater type receivers and amplifiers. Contains facts with which every serviceman should be familiar. Explains the "mystery" breakdowns encountered in actual practice.

4. VIBRATORS AND VIBRATOR POWER SUPPLIES
Complete, up-to-date information on the operating conditions and application of both vibrators and vibrator power supplies. Important facts about their design, and the requirements for satisfactory performance of vibrator-operated equipment.

5. PHONO-RADIO SERVICE DATA
Understanding of the mechanical and electrical principles involved makes servicing easier, quicker and more profitable. This chapter "tells all" . . . and has been called priceless by servicemen who have previewed it.

6. AUTOMATIC TUNING
In this section is a full description of the various systems of automatic tuning . . . how they work and how to adjust them. Every serviceman will profit from the information given here, since he'll use it constantly.

7. FREQUENCY MODULATION
Clear, concise, easy to read, this chapter provides a simple explanation of the design principles and operating conditions involved in FM circuits. It provides a solid foundation of knowledge for servicemen, radio engineers, amateurs and experimenters . . . anyone concerned with the practical applications of FM.

8. TELEVISION
This section provides the basic information needed to prepare for successful work in the television boom that is sure to follow the war. Understanding television now will pay dividends later.

9. CAPACITORS
Wartime servicing depends on making the best use of available components. This article shows how to install condensers for specific applications, without being dependent on duplicate replacements. Reading this article will help you make repairs promptly and assure your customers of satisfactory service.

10. PRACTICAL RADIO NOISE SUPPRESSION
You can easily become an expert on radio noise by applying the information provided in this chapter. New, down-to-earth, field-proven methods of solving practically any noise problem . . . How and where to use noise filters and much other data. Interestingly written, easy to understand.

11. VACUUM TUBE VOLTMETERS
This measuring device is proving increasingly useful in both radio work and industrial electronics. Here's a full explanation of how commercial vacuum tube voltmeters operate.

12. USEFUL SERVICING INFORMATION
All the general references a serviceman needs . . . tables, coding data, standards, design charts, etc. *Everyone* interested in radio will have frequent occasion to use this section.

13. RECEIVING TUBE CHARACTERISTICS
Complete tables covering all American tube types. Arranged in convenient form to save you time.

392 pages, 8½ x 11 inches, with valuable information much of which has never before been available. Profusely and accurately illustrated. The New MYE TECHNICAL MANUAL is durably bound in hard cloth covers with permanent sewed binding. Go to your nearest Mallory Distributor and buy this de luxe edition at the net price to radio servicemen—$2.00.

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Chicago School Trains Radiomen

UNITED STATES SIGNAL CORPS radio and electronics engineers, operators and technicians by the thousands are now trained annually for the duration at Illinois Institute of Technology in Chicago.

The program, which features the most complete electronics work being given anywhere in the Sixth Service Command — including ultra-high frequency or micro-wave techniques—is rapidly reaching full operation.

Already students in all the various levels of radio study at the Chicago school are figured in terms of four digits. When the program reaches top capacity, the continuous enrollment will be in the thousands, more than double the present figures.

The phenomenal growth of this technical training program is especially significant in view of the fact that it is a new type of work, developed almost entirely since the Signal Corps began its expansion program.

All of the course of study had to be planned and designed by Col. C. N. Sawyer of the Signal Corps and Illinois Tech faculty members—under the direction of Dr. Jesse E. Hobson, head of the department of electrical engineering at Illinois Tech, himself a young electrical engineer who finished his own graduate work only a few years ago—since never before had ultra-high frequencies been a part of the standard engineering curriculum.

Laboratory equipment — which is now valued at a minimum of $100,000 —also had to be designed and built largely by Illinois Tech engineers, since much of the apparatus needed was too new in principle to be manufactured by standard companies.

Other equipment being used included facilities purchased by Illinois Tech recently from the RCA Institute of Chicago. This equipment includes numerous pieces of apparatus actually used in radio work—including such things as 11 standard transmitters, ranging from tiny 10-watt stations to huge commercial transmitters—available at no other educational institutions.

New laboratories have been built on the Institute's Lewis campus in Chicago. Two of the largest laboratories are in a building constructed during the first World War for mechanics training, now reclaimed from private use for this new war job.

In addition to the micro-waves study—in which several hundred men are currently enrolled—the Illinois Tech program includes every phase of radio work from fundamentals on up to the advanced. Other groups now studying include an even larger number in "elementary radio engineering"—which precedes the ultra-high frequency work, and several hundred in part-time evening elementary study.

Together with evening war-training radio students and the regular Illinois Tech electrical engineering seniors, who are required to take the micro-waves work, the continuous enrollment in the radio training program will approximate "several thousand." Most of the courses are of either a 10- or 12-week duration, allowing four or five complete turnovers annually.

• • • — • —

Signal Corps Reference Library

ANNOUNCEMENT was made recently that a Signal Corps Reference Library has been established in Washington by Major General Dawson Olmstead, Chief Signal Officer of the Army. Friends of the Signal Corps Library committee under the chairmanship of Lt. Colonel W. L. Hallahan, 48 Wall Street, New York will assist the Chief Signal Officer in carrying out plans for collecting up-to-date technical and scientific items for inclusion in the new library.

Nationally known engineering societies have pledged their cooperation in making available books and periodicals that would be difficult to obtain through commercial outlets. Harold Osborne, president of the American Institute of Electrical Engineers, has organized a committee within the Institute to assist the Signal Corps in selecting the nucleus of the library. The field of interest covers electronics, radio, telephone, telegraph, engineering, electricity, meteorology, physics, chemistry, electron microphotography, photography (still and motion), cryptology, signal communication, pigeon breeding and training, direction finding equipment and many other technical subjects.

Technical books and pamphlets on the above named subjects may be shipped directly to the Signal Corps Reference Library, Office of the Chief Signal Officer, War Department, Washington, D. C. Contributors should make use of the special bookmailing rate of one and one-half cents per pound, not to exceed seventy pounds in any one package.

A Library Advisory Board, made up of officers on duty in the Chief Signal Officer's Office in Washington, has been appointed and will administer the library.

• • • — • —

W.E. Plants Awarded E's

THE "E" award has been given to all W. E.'s manufacturing plants, chief of which are the Hawthorne Works in Chicago, the Point Breeze Works in Baltimore, and the Kearny Works in Kearny, New Jersey.

There are also Western Electric distributing houses located in 29 strategic centers throughout the U. S. These supply depots, serving the local Bell Telephone company in each area, are located in Boston, New Haven, New York, Brooklyn, Newark, Philadelphia, Pittsburgh, Washington, Atlanta, Louisville, Jacksonville, New Orleans, Chicago, Detroit, Cleveland, Cincinnati, Indianapolis, Milwaukee, St. Louis, Kansas City, Dallas, Houston, Omaha, Minneapolis, Denver, San Francisco, Los Angeles, Seattle, and Portland. Western Electric installers operate throughout most of the U. S., readying switchboards for service in war industries and in Bell System telephone exchanges.

• • • — • —

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ELMENCO MICA CONDENSERS,
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Chamberlin-Trained Men

The Armed Forces and Wartime Industry alike are unanimous in their praise of the training for specialized duty provided by private schools of the type of Chamberlin.

The need for wartime service specialists is greater than government training facilities and instructors can humanly supply. The student who obtains training in basic fundamentals prior to induction performs a patriotic service. The more training he obtains the faster naturally will be his advancement. While higher rank is gratifying, satisfaction derived from contributing vitally needed skills to America's war effort has been the dominating thought of Chamberlin men!

Chamberlin-trained men, by the hundreds, are entering the armed forces. Trained under a proved curricula, these men, almost without exception, possess unusual capacities and intelligence, focused and sharpened for maximum service anywhere. They are ready for duty!

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AVIATION RADIO COURSE

by PAUL W. KARROL

Editors' Note—Although this special issue of RADIO NEWS is devoted to the U. S. Army Signal Corps the Editors have provided additional space so that our readers may continue their study of this important topic without a prolonged interruption.

BECAUSE installation and maintenance (I&M) of aircraft radio equipment is such highly specialized work, it, like any other phase of aviation radio requires trained personnel. Building upon a base of radio theory, then moving toward the study of equipment design, limitations, application, etc., later leading on to the more practical aspects of the subject through actual work and association with trained technicians results in a more comprehensive understanding of the many details which must be known.

Before one can become highly proficient in I&M he must, of course, determine before formal study what he must know to assume the grave responsibilities which will be thrust upon his shoulders when he assumes the duties of I&M technician.

Life often depends upon the radio equipment in an aircraft; indirectly upon the men who have installed and who maintain that equipment.

The prospective technician will leave no stone unturned in acquiring the necessary knowledge to work with aircraft radio equipment efficiently, if he is fully cognizant of the importance of this work.

It is not enough that he know radio theory and just a few scattered aspects of I&M to get along. Unless, of course, the work he performs is under the direct supervision of a trained technician. And even then, it would be folly to allow a student to do work without later carefully inspecting it.

The importance of good I&M cannot be stressed too highly.

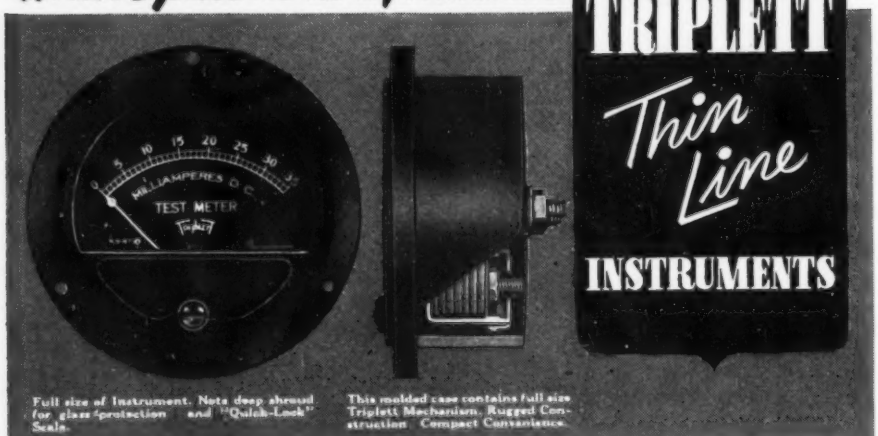
The main reason it takes personnel trained specifically for I&M work is due in part to the dissimilarity in equipment and aircraft design which necessitates performing many various types of installations and applying various service considerations. Trained personnel have, more or less, generalized all necessary details of equipment installation and maintenance so that they can be readily applied to nearly any aircraft radio installation.

The problems of installation can be classified into two distinct groups. The first group includes those problems encountered by the technician in the first phases of installation; viz., mounting space availability; weight distribution; power supply sources and capabilities; material and tool assembly, antenna considerations; and equipment layout. The second group will include problems encountered in the final phases of installation, viz., interconnection of installed components; testing of installed equipment; pre-flight tuning of equipment; ignition interference elimination and flight testing. (Immediately after an installation has been made and has been flight tested, all work performed on the installation is then classified as maintenance.)

Prior to the actual installation, the technician should consult instruction books always supplied with the radio

(*Continued on page* 254)

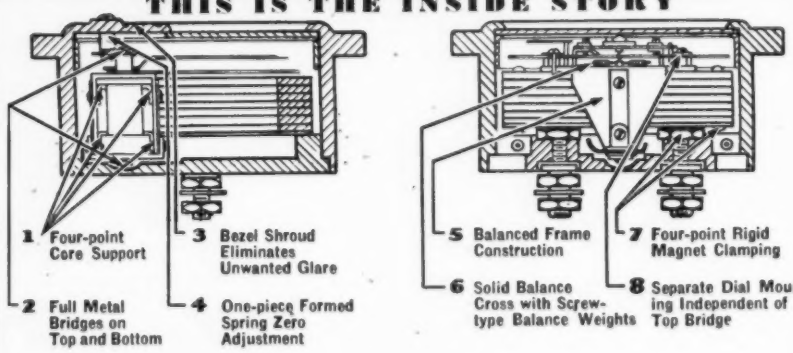
When Space is at a Premium



Full size of Instrument. Note deep shroud for glass protection and "Quick-Look" Scale.

This molded case contains full size Triplett Mechanism. Rugged Construction. Compact Convenience.

THIS IS THE INSIDE STORY


1 Four-point Core Support
2 Full Metal Bridges on Top and Bottom
3 Bezel Shroud Eliminates Unwanted Glare
4 One-piece Formed Spring Zero Adjustment
5 Balanced Frame Construction
6 Solid Balance Cross with Screw-type Balance Weights
7 Four-point Rigid Magnet Clamping
8 Separate Dial Mounting Independent of Top Bridge

Thin-Line Instruments also have Standard Large Coil Triplett Movements. Furnished with Osmium pivots for special requirements. All these features make for greater rigidity under vibration; greater permanence of calibration; greater user satisfaction.

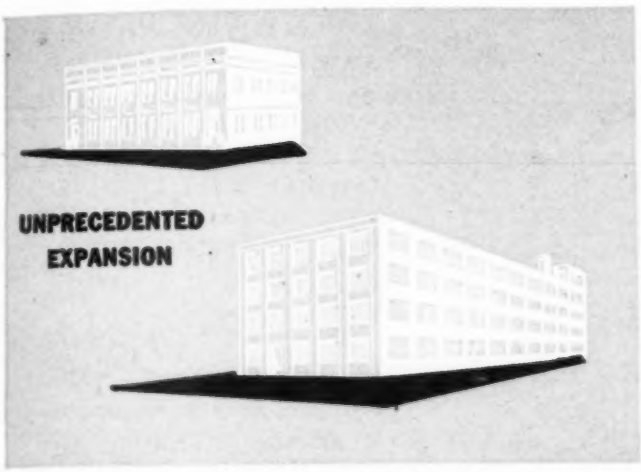
TRIPLETT Thin-Line

Triplett Thin-Line Instruments meet rigid requirements for dependable performance. Though occupying minimum space they are *not* miniatures. Mechanisms are standard size with emphasis on excellent performance over long periods. Standardized installation. Made in three styles of cases—Molded, Metal Wide Rim and Metal Narrow Rim.

Triplett Thin-Line Instruments, available for many industrial applications, can be depended upon for precision performance in limited space. For full details write for "Triplett Thin-Line Bulletin."

THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, O.

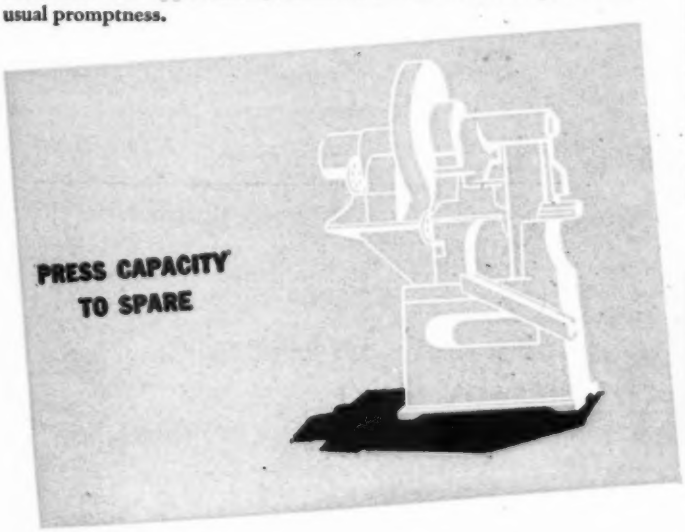
What Isolantite is Doing To Supply the Materials that Help Keep Communications Open

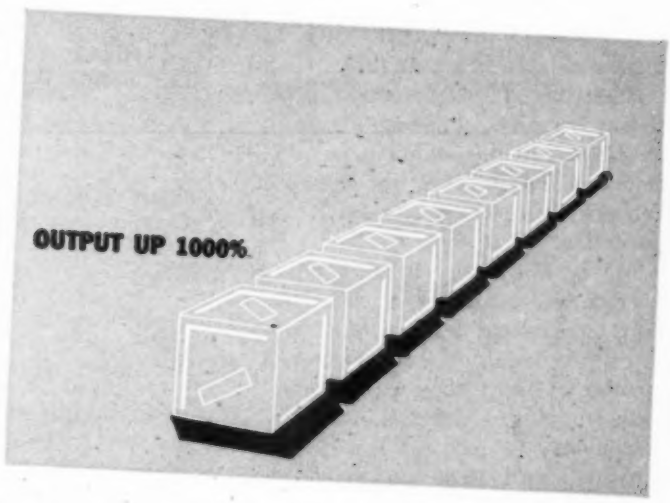


(*Above*) No one who hasn't been here to see it happen would recognize the great, humming plant that is Isolantite, Inc. today. Here at Isolantite the change has been extraordinary—even for these times. For the products of Isolantite serve the U. S. Signal Corps—the "ears" of our Armed Forces on every front.

(*Right*) Isolantite has not only met the most rigid Government specifications, but found ways to improve the quality of its products and service. Still newer bodies in process of development will increase the efficiency and reliability of communications equipment for wartime service, and promise finer performance in radio once the war is over.

(*Below*) In some fields of Isolantite activity, notably small pressed parts, there is output capacity to spare. When parts of this type are needed for war applications, Isolantite can make delivery with unusual promptness.





(*Above*) Isolantite has increased production of precision ceramic parts to ten times the level of two years ago. There is no pause in Isolantite's research for new and improved manufacturing methods, numerous and revolutionary as these have been.

ISOLANTITE

CERAMIC INSULATORS

ISOLANTITE INC., BELLEVILLE, NEW JERSEY

"Yessir, I'm IN A CLASS BY MYSELF!"

"Yessir, that's true! Ever since I enrolled for special training in Radio Servicing with the International Correspondence Schools, I've been 'in a class by myself.' Because every I.C.S. student is really a one-man class. His classroom is in his own home, and there aren't any slow-pokes or dunces to hold him back! He gets *personal, individual instruction!*

"Maybe that's why it takes only a few months for many I. C. S. students to get specialized training that 'pays out' in promotion or more money. As a matter of fact, a few weeks after I began studying, I was making enough extra money to pay for my I. C. S. Course — and that was just the beginning!

"Right now, of course, there's a terrific shortage of trained men in the radio industry — and if you're as smart as I think you are, you'll mark this coupon and mail it. And I don't mean tomorrow!"

LET'S GO! U.S.A. KEEP 'EM FLYING!

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☐ GENERAL RADIO
☐ RADIO OPERATING
☐ PRACTICAL RADIO SERVICING
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☐ SOUND-PICTURE PROJECTIONIST

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☐ Air Conditioning	☐ Mechanical Engineering
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☐ Architectural Drafting	☐ Patternmaking ☐ Plumbing
☐ Architecture ☐ Boilermaking	☐ Practical Telephony
☐ Auto Engine Tune-up	☐ Public Works Engineering
☐ Auto Technician ☐ Aviation	☐ Radio Operating
☐ Bridge Engineering	☐ Radio Servicing
☐ Building Estimating	☐ R. R. Engineering
☐ Chemistry ☐ Coal Mining	☐ R. R. Section Foreman
☐ Civil Engineering	☐ R. R. Signalman
☐ Concrete Engineering	☐ Reading Blueprints
☐ Contracting and Building	☐ Refrigeration
☐ Cotton Manufacturing	☐ Sheet Metal Work
☐ Diesel Engines	☐ Ship Drafting
☐ Electrical Drafting	☐ Shipfitting
☐ Electrical Engineering	☐ Shop Practice
☐ Electric Lighting	☐ Steam Electric
☐ Foundryman ☐ Heating	☐ Steam Engines
☐ Heat Treatment of Metals	☐ Structural Drafting
☐ Highway Engineering	☐ Structural Engineering
☐ House Planning ☐ Machinist	☐ Surveying and Mapping
☐ Industrial Metallurgy	☐ Telegraph Engineering
☐ Locomotive Engineer	☐ Textile Designing
☐ Managing Men at Work	☐ Welding, Electric and Gas
☐ Marine Engines	☐ Woolen Manufacturing

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Issuance of Amateur Station Licenses Discontinued

THE Commission by its Order No. 87-B adopted September 15, 1942, has discontinued the issuance of new, renewal, or modified amateur station licenses until further order of the Commission. This action has been taken in view of the many difficult administrative problems which have arisen in connection with the issuance of amateur station licenses as a result of the war. Inasmuch as many licensees are in the military services or engaged in war industries in various parts of the country, it is impossible for such station licensees to exercise proper control of transmitting apparatus and the control of the premises upon which such apparatus is located as required by the Rules and Regulations Governing Amateur Radio Stations and Operators.

Commission Orders No. 87 and 87-A adopted December 8, 1941, and January 8, 1942, respectively, require complete cessation of all amateur radio operation in the interest of national security. The Commission, however, continued to renew and modify existing amateur station licenses in view of possible utilization of such stations in connection with Civilian Defense activities. The establishment of the War Emergency Radio Service, however, will provide Civilian Defense and State Guard organizations with the desired emergency communication in connection with national defense and security. The Commission will continue its policy in regard to the issuance of new or renewed amateur operator licenses or modification of such licenses for change in operator privileges. The holder of an amateur operator license desiring to maintain his amateur status should submit application for amateur operator and amateur station license renewal in accordance with the Rules.

With respect to amateur station licenses which are valid as of the date of adoption of Order No. 87-B and are not revoked prior to their expiration, it is contemplated that the licensees thereof, who maintain valid amateur operator licenses, will be granted appropriate amateur station authorization when amateur stations are again allowed to be operated, subject to the filing of such additional application(s) as may be required. It is further contemplated that the future operation of amateur stations will be authorized upon such bands of frequencies as may then be allocated to the amateur service.

Insofar as it is possible and practicable to do so, the call letters of outstanding amateur station licenses will be reserved for assignment to the present station licensee upon proper application when licensing of amateur stations is resumed.

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Now—more than ever—prepare yourself for an all-important career as a radio operator or instructor!

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8 months' course by U. S. Government licensed instructors. Write today for details!

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VACUUM TUBES

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SPECIAL ALLOYS made to meet individual specifications . . .

Write for list of stock alloys

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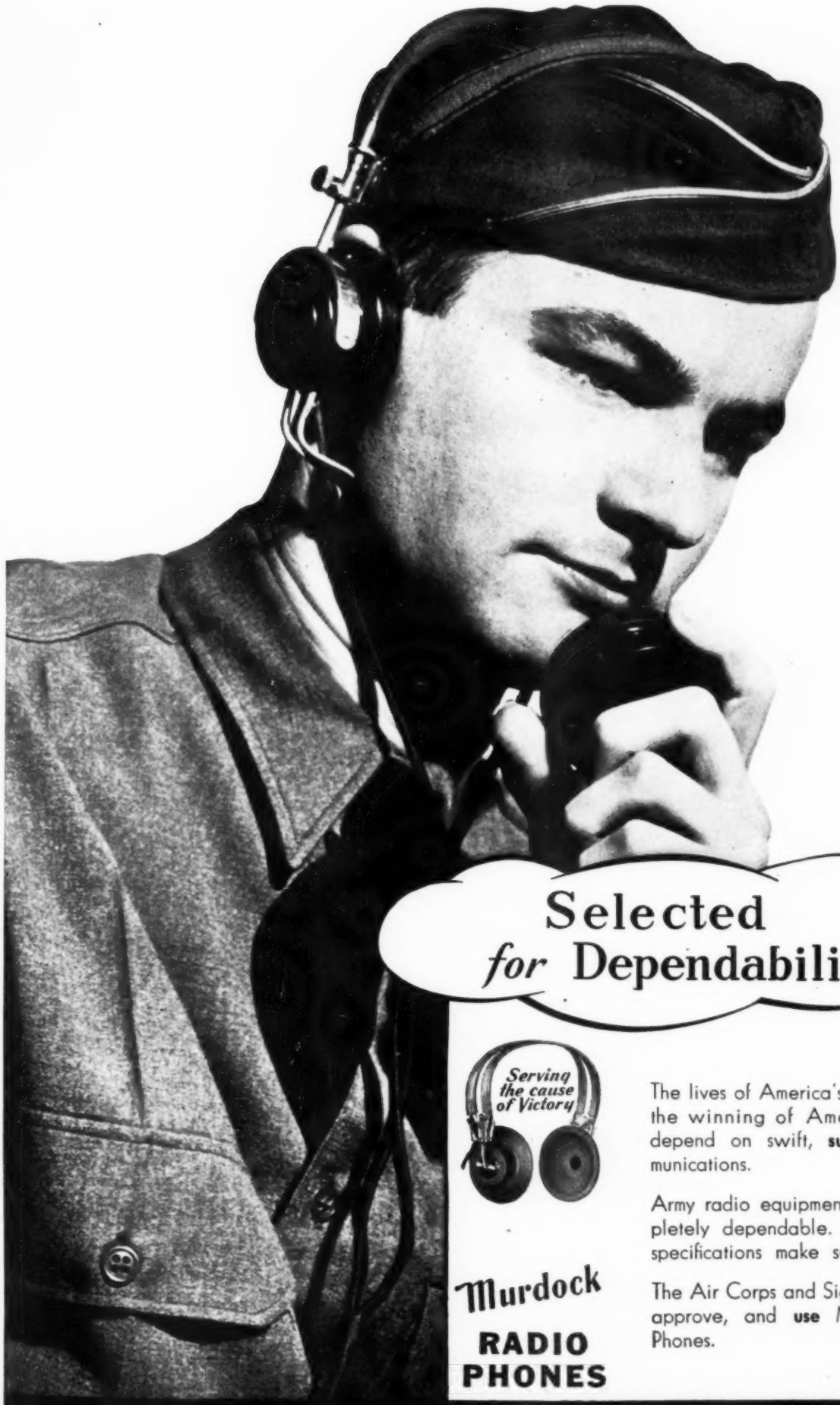

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RADIO PHONES

The lives of America's fighting men—the winning of America's battles depend on swift, **sure** radio communications.

Army radio equipment **must** be completely dependable. Exacting Army specifications make sure it **will** be.

The Air Corps and Signal Corps test, approve, and **use** Murdock Radio Phones.

MURDOCK MANUFACTURING COMPANY—Chelsea, Mass.

Communications Has Its Heroes Too!

THE tough Marine riflemen aren't the only heroes in the Corps. The Marines who man the communications system have their share of heroes, too.

The average citizen seems to have the idea that the "rifle totin'" Marine gets all the action, fighting and excitement. Not at all. The members of the communication section have a job that requires steady nerves, and quick thinking while under fire. And to prove that, already in this war nine Marines in communications have received citations and awards.

For instance, there's the story of 22-year-old Corporal Harold R. Hazelwood of Stark City, Missouri. Corporal Hazelwood was one of the first enlisted men to be singled out for courageous action in World War Two. He received the Navy Cross for his bravery and devotion to duty during the initial Jap attack on Midway Islands, December 7, 1942.

When two Jap ships fired the first shots on the group of islands that historic night, Corporal Hazelwood was standing by on Sand Island as switchboard operator. He was at the command post of a defense battalion, under the command of First Lieutenant George H. Cannon.

Coolly all hands waited as the Nipponese cruiser and a destroyer plowed confidently near the range of the shore batteries. Twenty minutes passed slowly. Then a violent exchange of fire between ships and shore began.

Before the action ceased, one of the Japanese shells struck the command post in which Corporal Hazelwood was stationed. A fragment of the bursting projectile pierced his left leg, inflicting a severe fracture. The same shell seriously wounded his commanding officer, Lieutenant Cannon, and temporarily disrupted communications to the gun battery.

The young corporal ignored his wounded condition and instantly set up his switchboard again and re-established communication, transmitting the commands of Lieutenant Cannon, who refused to leave his post. Both men were removed and Lieutenant Cannon died from loss of blood. Lieutenant Cannon later was awarded the Congressional Medal of Honor posthumously for his heroic action.

Another outstanding case occurred during the same attack on Sand Island. The hero—Corporal Dale Peters, of a Marine communication platoon. When the Jap attack came, a shell struck Corporal Peters' station and the explosion blew him through a window onto the roof of a hangar. He staggered to his feet, dazed and hurt. Making a mis-step, he fell to the ground, 14 feet below.

In spite of his condition Corporal Peters staggered over to a nearby hangar which had burst into flames, and started helping Marines who were working furiously removing large aerial bombs stored in the structure. Flames and smoke enveloped the men. Any second one of the powerful charges might explode. But Peters and his comrades stuck to their jobs until the bombs were all removed.

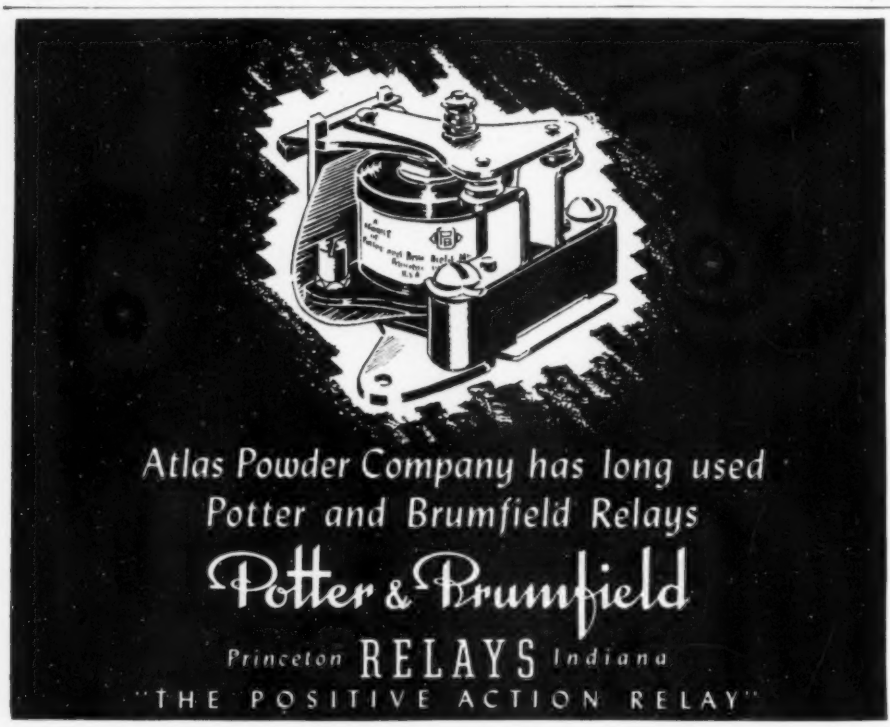
For this heroic action, 25-year-old Corporal Peters, of Breckenridge, Mich., was awarded the Navy Cross by the President. Subsequently, he was promoted to the rank of sergeant and later to staff sergeant.

Other Marines in communications who have received awards and citations are: Corporal George Merton Beuthe, who was awarded the Order of the Purple Heart for gallantry in action in the Manila Bay area.

Corporal Francis S. Parker, awarded the Silver Star, also for gallantry in action in the Manila Bay area.

Private First Class Donald E. Lake, awarded a Silver Star for valorous action in the Manila Bay area.

And Silver Stars also were awarded to Private First Class Thomas L. Stewart and Sergeant John R. Breeze for their heroic service in the same area. Corporal Floyd B. Jimerson was awarded a letter of commendation for the part he played in the Manila Bay area, and also earned a silver life saving medal from the Treasury Department.



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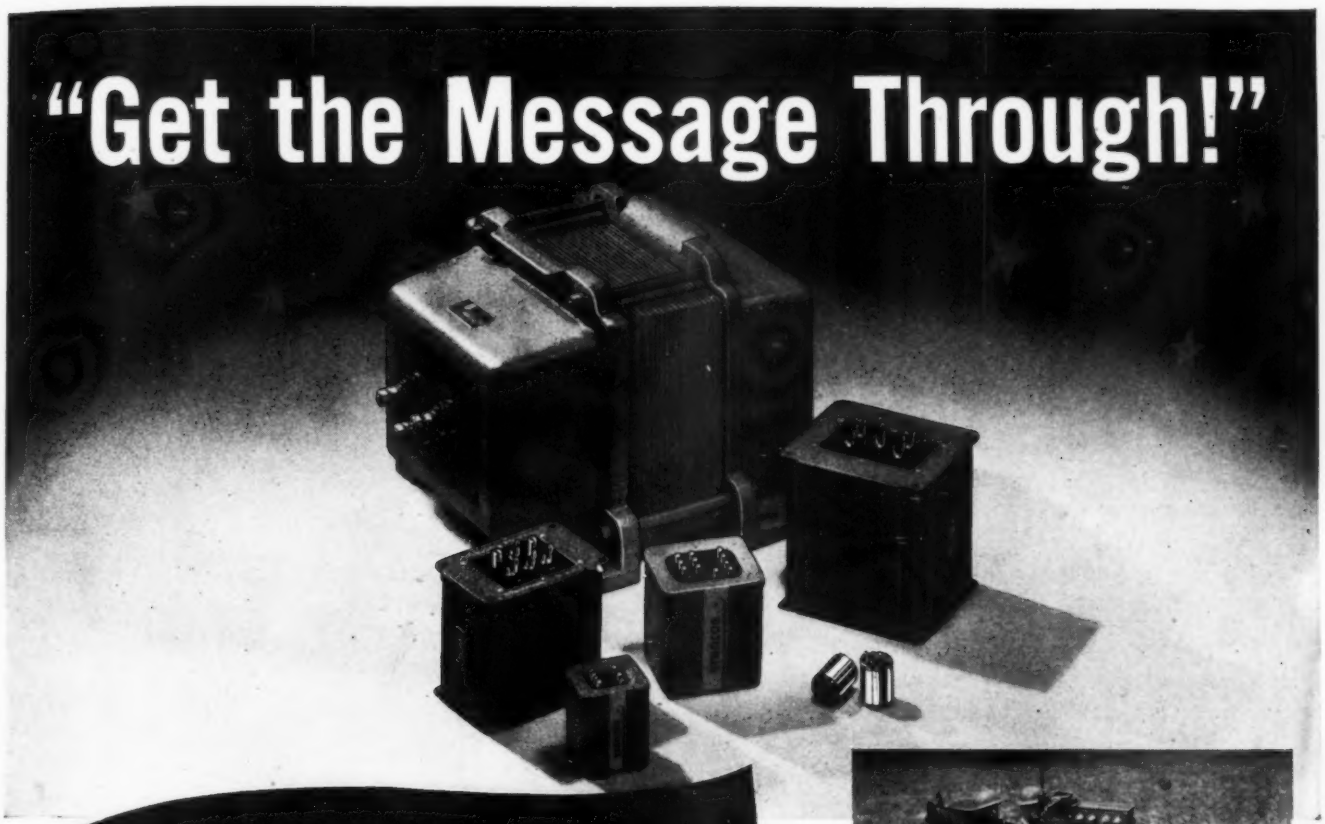
SPECIFICATIONS:

1. Combination R.F. and A.F. Signal Generator, R.F.—100 K.C. to 90 Megacycles, A.F.—200 to 7500 cycles; Sine-Wave, — WITH OUTPUT OF OVER 1 VOLT. All direct reading, all by front panel switch manipulation.
2. R.F. and A.F. output independently obtainable, alone or with A.F. (any frequency) modulating R.F.
3. Latest design full-range attenuator used for controlling either the pure or modulated R.F.
4. Accuracy is within 1% on I.F. and broadcast bands; 2% on higher frequencies.
5. Giant dial etched directly on front panel, using a new mechanically perfected drive for perfect vernier control.
6. Operates on 90 to 130 V. A.C. or D.C. (any frequency).

The Model 1230 comes complete with tubes, shielded cables, molded carrying handle and instructions. Size 14" x 6" x 11". Shipping weight 15 pounds. Only $14.85

SUPERIOR INSTRUMENTS CO. 227 Fulton St., Dept. RN-11 NEW YORK, N. Y.

"Get the Message Through!"



STANCOR
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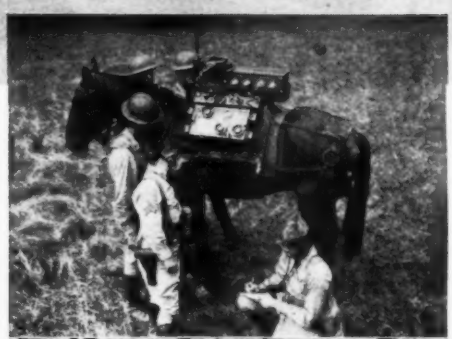
TRANSFORMERS



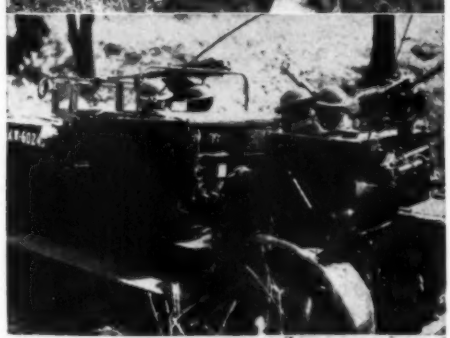


PHOTO BY U. S. SIGNAL CORPS

"GET THE MESSAGE THROUGH!"—the slogan of the U. S. Signal Corps—typifies the importance of communications in our armed forces.

★★★★STANCOR is geared to the vital necessities of the Signal Corps. Lives depend upon it! Successful operations depend upon it! "Unfailing accuracy" therefore is the STANCOR watchword.

Laboratory research and skillful engineering always have been highly important in the production of STANCOR Transformers. Now, more than ever before, these factors are emphasized in many new fields and in many new uses.

Illustrated above are a few of the many "MADE-TO-ORDER" STANCOR Transformers that are "precision performers." We can assist you in solving your transformer problems and meet your needs in compliance with exacting government specifications. Submit your requirements today.

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MEMO: TO 30 MILLION AMERICANS!

Month after month . . . advertisements like this one are telling the nearly 30 million readers of the SATURDAY EVENING POST and of LIFE of the part Stromberg-Carlson is playing in producing for victory! We sincerely hope that this advertisement and others yet to come will reflect credit not only on our workers . . . but on Stromberg-Carlson Dealers everywhere . . . and on the Stromberg-Carlson radios they sell.

STROMBERG-CARLSON, Rochester, New York

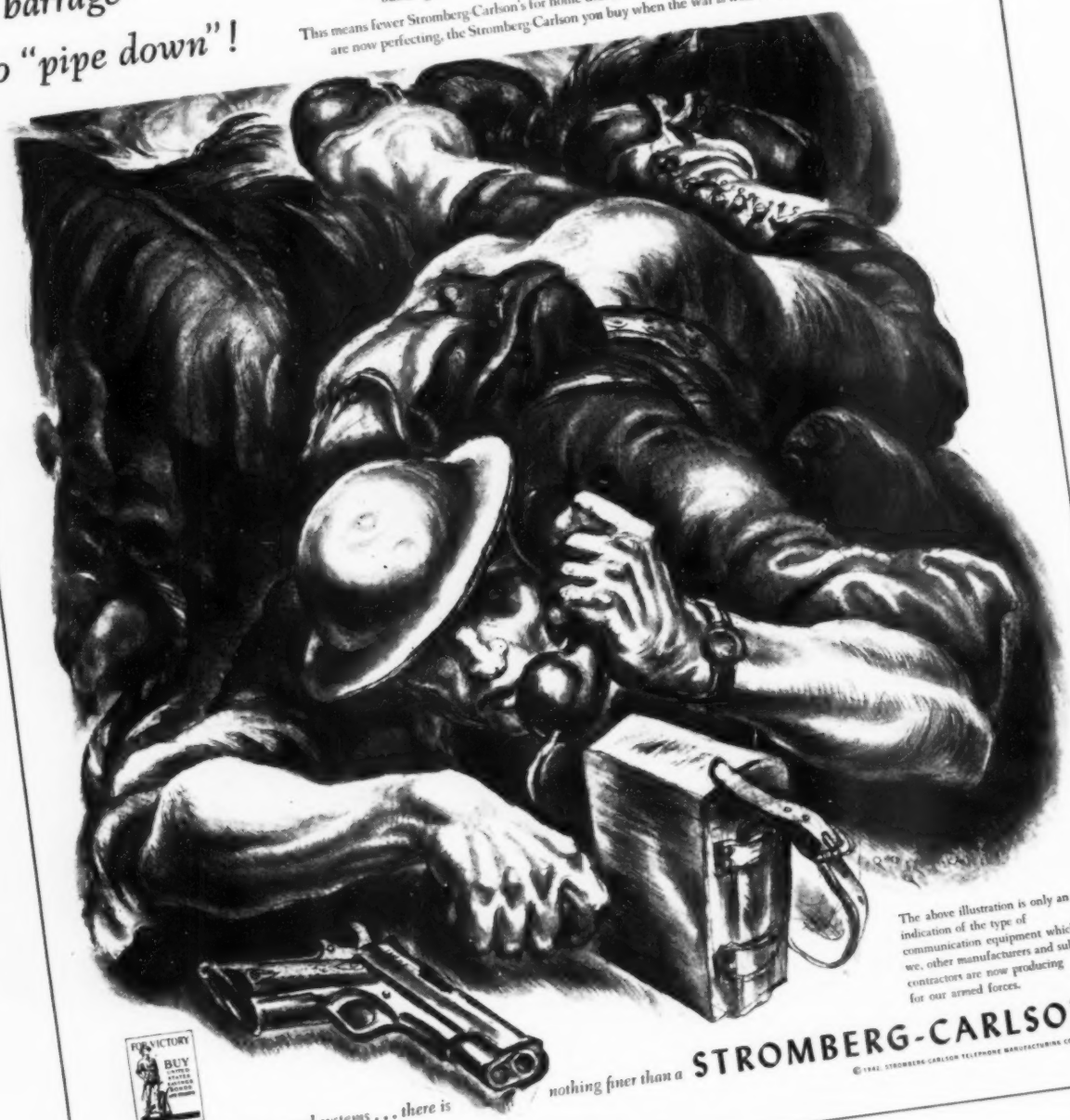
You can't tell a barrage to "pipe down"!

YOU CAN'T ASK the operator for *a better connection* when you're flat on your belly in a fox hole! You're on *a party line* with all the noises of hell . . . and you must have . . . you've got to have communication equipment of the highest reliability, the utmost durability

For 48 years Stromberg-Carlson has been perfecting just this kind of equipment!

Today the same skill that *pioneered in FM radio* is concentrating almost exclusively on building communication equipment for our Army, Navy and Air Forces.

This means fewer Stromberg-Carlson's for home use. However, with the new developments our laboratories are now perfecting, the Stromberg-Carlson you buy when the war is won will be even finer than it is today!



The above illustration is only an indication of the type of communication equipment which we, other manufacturers and sub-contractors are now producing for our armed forces.

FOR VICTORY BUY UNITED STATES DEFENSE BONDS AND STAMPS

In radios, telephones, sound systems . . . there is *nothing finer than a* STROMBERG-CARLSON

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A PLEDGE TO THE *Signal Corps*

Every employee has enlisted with determined enthusiasm in Tung-Sol's campaign for a complete and undelayed VICTORY. They are all proudly aware that Tung-Sol radio tubes and lamps play key roles in the swift, sure transmission and reception of battle commands. To the Signal Corps, as to all other divisions of the armed forces, Tung-Sol workers have made this pledge... That they will unfailingly produce this essential equipment in QUANTITY, QUALITY and ON TIME.

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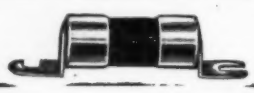
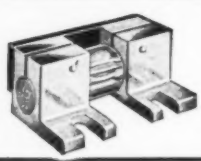
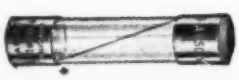
FACTORIES: NEWARK, N. J. SALES OFFICES — ATLANTA • CHICAGO • DALLAS • DENVER • DETROIT • LOS ANGELES • NEW YORK

Know the LITTELFUSES
SPECIALLY DESIGNED FOR

AIRCRAFT • RADIO • COMMUNICATIONS • TANKS
MARINE SERVICES • P.T. BOATS • SUBMARINES • ORDNANCE
—Protection of Motor Circuits, and All Instruments

(1) 	(1) A.C. No. 30284. Army Air Corps Littelfuse. Fibre-enclosed. 1 to 300 amps., 125 volts rating. for aircraft, motor circuits, and general protective purposes.
(2)	(2) A.C. No. 32271. Glass-enclosed Littelfuse for general protection. Ratings 20 amps. or less. Carry rated current indefinitely blow in 30 min. at 125% of rating.
(3)	(3) 4 A.G. Anti-Vibration Type Aircraft Littelfuse. Glass-enclosed. 1¼" x 9/32" dia. 1 to 50 amp. rating.
(4)	(4) 4 A.B. Anti-Vibration Type Aircraft Littelfuse. Fibre-enclosed. 1¼" x 9/32" dia. 1 to 60 amp. rating.
(5)	(5) 5 A.G. Anti-Vibration Type Aircraft Littelfuse. Glass-enclosed. 1½" x 13/32" dia. 1 to 60 amp. rating.
(6)	(6) 5 A.B. Anti-Vibration Type Aircraft Littelfuse. Fibre-enclosed. 1½" x 13/32" dia. 1 to 60 amp. rating.
(7) 	(7) Heavy Duty Hi-Amp. Anti-Vibration Littelfuse. Rating 40 to 150 amps. 1¾" standard length. 1½" for ratings to 100 amps. Transparent body for easy inspection.
(8)	(8) High voltage Aircraft Radio Littelfuse. 1000, 2500, 3000 volt-rating. 3", 4½", 5½" long. Amp. ratings as low as 1/16 amp. Designed to clear short circuits on power supplies up to 2 K.W. rating.
(9)	(9) Instrument Littelfuses, 1/200 amp. to 15 amps. rating. For galvanometers and other delicate instrument equipment—radio tubes, testers, radio amplified tubes, Radio "B" circuits, and thermocouples, production test equipment, railway signal meters, etc. Locked Cap Assembly.
(10) 	(10) 3 A.G. 250 to 500 volt Littelfuses, 1/16 amp. to 3 amp. rating, for radios, amplifiers, fractional h.p. motors, magnets, power supplies, rectifiers, plate circuits, etc. Locked Cap Assembly.
(11)	(11) 3 A.G. 250 volt Slo-Blo Littelfuses, 1/100 amp. to 1 amp. rating. For applications requiring high time lag. For radios, amplifiers, control circuits, relays, interrupters, vibrators, magnets, etc.

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New AAF Radio Courses

SCOTT FIELD, ILL.—An airplane identification course and study of code with static are two new features of the revised Radio Operators' course recently inaugurated at this radio university of the Army Air forces, Col. Wolcott P. Hayes, commanding officer, said recently.

Student operators will receive the two-week identification instruction toward the end of their course. In it they will be taught to recognize the aircraft of all nations under any circumstances. It is felt that such knowledge is vital to members of plane or ground crews.

because

good needles are more important than ever . . .

Don't Take Chances—

USE TIME TESTED —MODERN— AMERICAN MADE NEEDLES

ACTONE 100% Shadowgraphed
BRILLIANTONE STEEL
BRILLIANTONE BRASS PLATED
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With phonograph record production cut 70%, it's plain to see that record users will want extra life from the old records and from the new ones they buy. This extra life can be had by using carefully selected needles. Use any of the above mentioned needles, they set the standard from which others are measured.

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LAFAYETTE

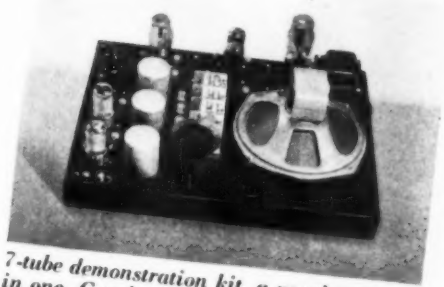
Gives QUICK, ACCURATE Service!

Lafayette carries complete stocks of Radio and Electronic equipment for every purpose. Radio Training Kits for schools available for immediate shipment. Requirements for the Signal Corps will receive our undivided attention. We have two conveniently located distributing points where you will receive accurate service and prompt attention to your inquiries.

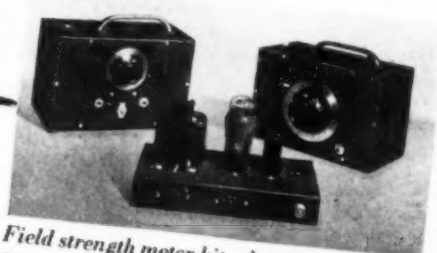
Kits illustrated are representative of those that can, and are, being used for Signal Corps training—these are only a part of the complete Lafayette line. Accredited training schools may obtain schematic diagrams of the kits used in military training programs.

Radiophone Kit—complete RF modulator and power supply on one chassis. For instructions in maintenance and tuning. Can be keyed for code work.

Lafayette Super "Stylelined" 75-100 Watt indoor system. As many mikes and speakers as required may be added. Ideal for recreation halls, paging, instructing, drilling, etc.



7-tube demonstration kit, a number of kits in one. Can be built in stages, each stage inter-connected with tip jacks. 1st a Det. circuit, then RF circuits, etc. When finished there are 2 stages of RF and Det. 1st audio and beam power push-pull audio and power supply. Circuit diagrams will suggest many uses.



Field strength meter kit—built into shielded case, checks operation of transmitter kit visually through meter jack, and audibly through phone jack. Signal Generator Kit —contains all necessary parts to make a three range signal generator. Used to instruct students on frequency calculation and aligning technique. Utility Audio Amplifier Kit—has sufficient gain to operate with crystal microphone. Teaches simple audio amplification.

★ *Amplifiers!—5 watts and up. Our engineers can furnish quotations on all types of sound installations.*

★ *Immediate delivery on McElroy keys, tape centers and recorders.*

★ *Lafayette 416-XO Oscillator-Amplifier—capable of supplying a tone source to 300 headsets at 800 cycles per second ± 10%.*

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RADIO PARTS!—
GUARANTEED ALL NEW
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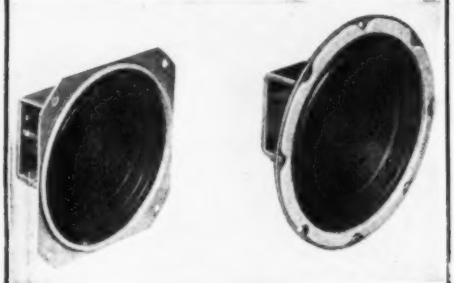
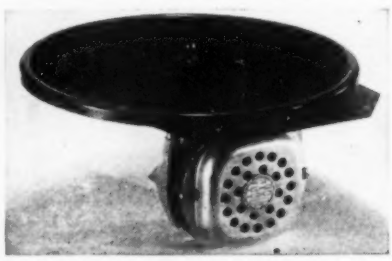
ASTATIC CRYSTAL PICK-UPS!—high grade, low pressure pick-up. Statuary brown finish with single hole mounting bracket. Mounting center 7". Plays up to 12" records . . . your new low price.....**$2.95 each**



P.M. SPEAKERS!—All new—thousands in original cartons. 4" and 5", good heavy construction. V. C. impedance 3-4 ohms. (Less transformers) 4" at ....**89c each** 5" at....**$1.10 each**



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SERVICEMEN'S SPECIAL! — 10 lbs. Radio Parts Kit. An assortment of controls, switches, coils, variables, resistors, condensers, etc., all perfect and brand new! **only $2.95**

SPAGHETTI TUBING . . . 3 foot lengths . . . flexible . . . red, yellow, green and black . . . 12 lengths.....**$1.00**

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DROP A POST CARD TODAY

RANDOLPH RADIO
600 WEST RANDOLPH ST., CHICAGO, ILL.
"Millions of Parts for Millions of Radios"

Aviation Radio

(*Continued from page* 244)

equipment. These books contain suggested installation procedure for the equipment concerned, general maintenance data, and operational advice.

Glancing through an instruction manual which covers *Bendix Aviation Ltd.'s* Communications Systems Models 3801 and 3801-24, we see it is properly indexed and presents a general description of the equipment.

Then it describes the various units and goes into an installation description. Tuning and operation are then covered with some data on receiver alignment. Dynamotor maintenance is given some space and in the middle of the book we find photos of the equipment assembled and disassembled. Further on we see charts covering selectivity, sensitivity, fidelity, and receiver AVC voltage curves. Diagrams are supplied separately.

A technician using this manual obtains all essential installation and maintenance data. With diagrams supplied with the equipment it is possible for him to shoot trouble in a minimum amount of time if proper test equipment is used in conjunction with the circuit drawings.

After perusing the manufacturer's instruction manuals the technician must decide where each component must be installed for operational ease and maximum efficiency. Mounting space availability is a factor which enters into any installation regardless of the size of the aircraft; predominating, of course, in the smallest. After ascertaining the amount of space available for the installation, it is then necessary to consider weight distribution.

Proper weight distribution is a problem that can only be solved after consulting the aircraft manufacturer or referring to records which cover previous installations that, more or less, are similar to the one contemplated. Inquiries regarding suggestions for equipment placement are usually given prompt attention by the aircraft manufacturer.

In some instances, an unwary aircraft owner will purchase radio equipment before consulting a technician. Power capabilities of the aircraft electrical system were forgotten in the transaction with the result that the aircraft owner obtained equipment which requires more power than is available.

It is necessary that the technician check the power capabilities of the electrical system of the aircraft in which the installation is to be made. This check will include figuring the power capabilities of the generator and battery. In case the equipment requires more power than is available, it will be necessary to change both the generator and the

(*Continued on page* 260)

Instant action, split second communication Keeps 'Em Rolling

Talk-A-Phone gives you personal control of every division in your organization. Saves time, money, gets things done in a hurry. Puts your ideas into action at once, relieves switch boards, reduces errors — gives you the smooth coordination you need for real results.

TALK-A-PHONE IS BETTER

Because-

- More Versatile—unlimited number of stations and combinations
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WRITE . . . For Complete Details and Name of Your Nearest Jobber

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Flight 54 lands on two strips at once!

The big ship wheels at the end of its run and clears the landing strip for the next arrival. But up in the control tower important data of its flight is caught for good on another kind of strip—the slow-moving recording belt in the Dictaphone Electricord Belt Recorder.

On this a permanent record of all tower-plane communications is made. Inexpensive, flexible and practically unbreakable, each belt is folded and filed away when its work is done. Developed for the requirements of the Civil Aeronautics Authority, this Dictaphone continuous recorder is but one form of the new Electricord equipment. Another type, which also records from any type of electrical communications, and also reproduces, is serving the U. S. Army Signal Corps and other Services.

These special developments now reserved for the armed services and their direct suppliers are typical of the achievements of Dictaphone research. They are considered essential to the war effort as is the actual production of ordnance items in which Dictaphone is principally engaged.

Dictaphone Corporation, 420 Lexington Avenue, New York, N. Y.

DICTAPHONE ACOUSTICORD DICTATING EQUIPMENT
ELECTRICORD RECORDING EQUIPMENT

The word DICTAPHONE is the Registered Trade-Mark of Dictaphone Corporation, Makers of Dictating Machines and Accessories to which said Trade-Mark is Applied.

Find Garcia!
Only 41 years ago, when President McKinley asked Rowan to take the famous "Message to Garcia," there was no better way of communicating . . . . but today with the U. S. Army Signal Corps equipment you can communicate with a modern Garcia in a matter of SECONDS!
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SPEECH REPRODUCERS
6601 SOUTH LARAMIE, CHICAGO
SPECIALISTS IN ACOUSTIC RESEARCH AND PRODUCTION FOR MILITARY ADAPTATIONS
Join the U.S. Army Signal Corps!

Sound Recording

(*Continued from page* 150)

fiers are undesirable in the field because they are heavy consumers of "B" battery current, and they require the most expert adjustment and maintenance. The optical azimuth of the Class "B" push-pull recorders has been carefully adjusted by the recorder manufacturer to fit the laboratory processing used.

A single system sound camera equipped with a Class "B" push-pull variable area modulator is being used by one field unit, with the same advantages as those mentioned above for double systems.

For location exteriors small pressure-type microphones are used, provided with wind screens when necessary. The microphones are mounted on either folding floor stands or small booms.

Optimum sensitometric conditions for variable area track are determined by listening tests and crossmodulation measurements. Laboratory control is maintained by the measuring of sensitometric strips and modulated oscillator records.

Sensitometric conditions for variable density sound track are determined through listening tests. An intermodulation measuring panel is being set up for use in variable density control.

No claim is made to unusual channel set-ups or operations. This is a production organization, faced with heavy production schedules, and there is time for only the minimum necessary engineering. Therefore, standard tried-and-tested equipment and procedures are used wherever compatible with the service requirements. Cooperation of the manufacturers of equipment and supplies has been of great assistance.

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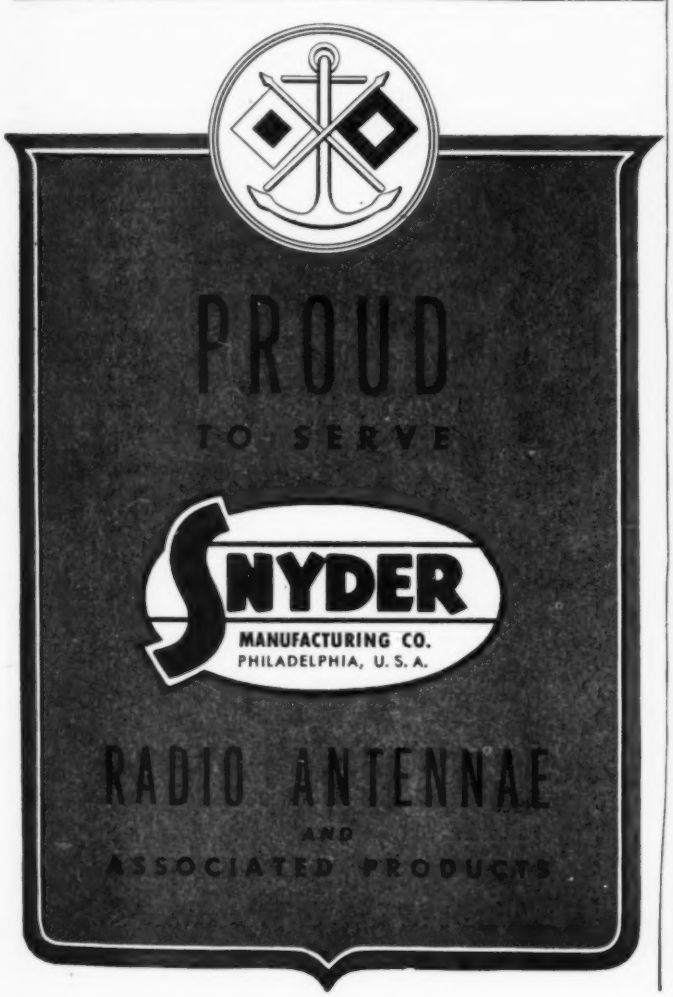

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BRASS • COPPER • TIN
ALUMINUM • IRON • STEEL
LEAD • NICKEL • ZINC
AND ALL OLD SCRAP METAL
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TUNGSTEN LEAD-IN WIRES • TUNGSTEN WELDS • TUNGSTEN & MOLYBDENUM SUPPORTS
FOR ELECTRONIC APPLICATIONS • TUNGSTEN CONTACTS FOR ELECTRICAL APPLICATIONS

Procurement of Signal Equipment

ORIGINALLY dividing the continental United States into three procurement districts, the Signal Corps has found it essential to streamline its procurement and Signal Depot organization in order to conform with best business practices and in order to expedite the procurement of the vast amount of technical equipment required to maintain Signal communications in the vastly expanded army.

In addition to the three districts mentioned there have been added procurement agencies at the Signal Corps laboratories and at the Aircraft laboratories in the Middlewest. The functions of these agencies is to procure the many thousand individual items of Signal Corps equipment from a radio tube to a complete unit of the most highly complicated communications equipment. This includes all types of equipment from telephone, land lines and teletypewriter apparatus to that which is associated with the newest developments in radio.

In addition to the local procurement function, the depots are charged with the issuance of equipment to combat units in all of the far-flung theaters of this global war.

The actual storage of equipment is also taken care of through Signal depots established in strategic areas. They are also charged with the repair of equipment in what is known as the third repair echelon. To the uninitiated this simply means that all basic repairs must be made at some distance behind the actual theater of operations. Preliminary repairs such as replacements of burned out tubes, etc., can be made up in the assault areas while repairs that require the soldering of wires, etc., are done in the so-called second echelon of repair.

Along with the decentralization of the storage, issue and repair functions and the consequent expansion of the corresponding units, has gone a proportionate growth in the personnel to operate them. Figures at the present time are not being made public.

Probably an explanation as to the organization duties and functions of a typical depot will serve to explain the workings of all such installations. Each depot is organized with an officer in charge and his executive staff. The basic functions are divided among administrative, local purchase and storage and issue divisions. As the name implies, the administrative division handles all matters of personnel, civilian training and service, along with the very important fiscal functions. Local purchase concerns itself with the procurement of all items purchased locally. The last division, namely storage and issue, has to do with warehouse control, the maintenance of records, establishment of repair shops and all matters of shipping and issue of this equipment to the using units.

In such a brief cross-section of the mission, organization and functions of the Signal Procurement districts and the Signal depots there is not much opportunity to go into the thousand-and-one details that are associated with the direction of these agencies. The streamlining of control and purchase has speeded up the problems of procurement, storage and issue and by just so much are bringing us closer to our final objective—victory in this war.

• • • — • —

CINAUDAGRAPH
SPEAKERS
INC.

A TOP FLIGHT NAME IN
SPEAKERS OR WAR WORK!
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FOR COMBAT WARFARE

Do you recognize these batteries? Most of them are identical with the Burgess batteries you know so well. Same high grade material—same workmanship—same quality. The only change is in face—the Signal Corps label has replaced the familiar Burgess medallion. They're batteries of war now!

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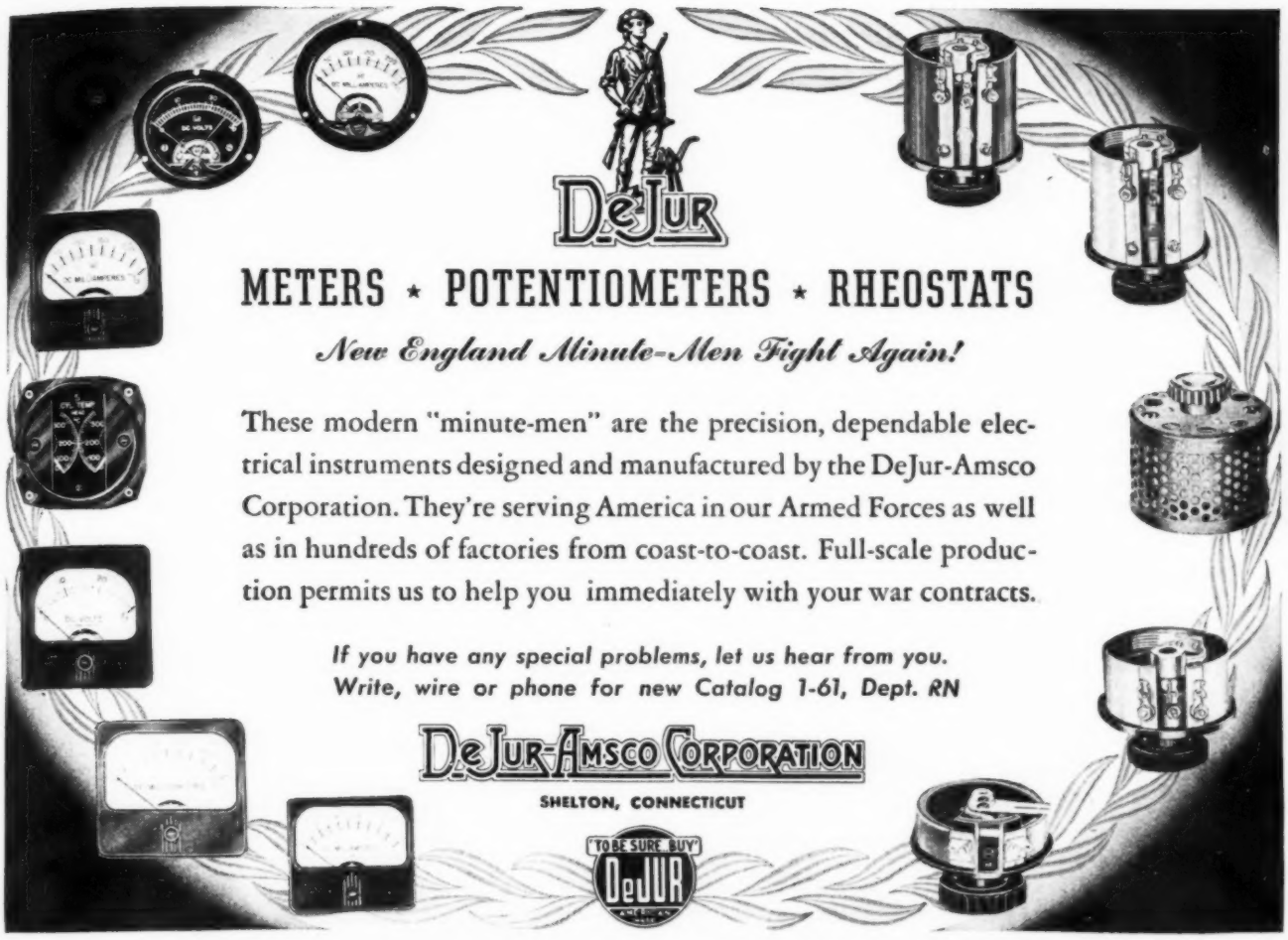
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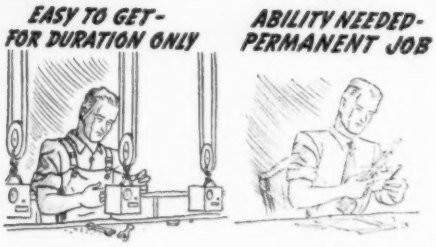

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Aviation Radio
(*Continued from page 254*)

battery and/or batteries and even a great part of the wiring; or exchange the radio equipment for equipment requiring less power. This is important!

If the aircraft owner purchases his equipment from a dealer who has the owner's welfare in mind he will ascertain the type of aircraft possessed and inquire as to whether or not a generator and battery are installed. He will then figure out the power capabilities of the craft's electrical system and make recommendations to the aircraft owner. He will not attempt to sell him equipment which will not operate in his aircraft.

Antenna considerations were covered in a previous lesson so they will not be presented here.

Material and tool asembly is a large problem to the novice. The questions: "What material in addition to the radio equipment will be needed for an average installation? How is this determined? What tools will be needed?" are questions often asked by the inexperienced technician.

In addition to the radio equipment consisting of receiver, transmitter, etc., a certain amount of tape; shellac; resin-core solder; assortments of wire (depending upon the installation); wire braid for bonding and shielding; tuning gear lubricants; conduit clamps; conduit; assortment of bolts, nuts, lockwashers, etc., should be on hand. If no records are available on past installations similar to the one which is to be made, the technician must figure out what is needed for the job by placing the equipment in approximate position in the aircraft and running connecting cables, etc., and making a list of materials which may be used. At the same time he can make a mental inventory as to the tools he should provide himself with to make the installation. Generally, the items given above will be needed in addition to other special items needed for a particular installation, such as: special mounting brackets, special standoff insulators, etc.

The tools most used will be the following: A pair of diagonal pliers, socket wrenches (assorted sizes); end wrenches (assorted sizes); hack-saw; soldering irons (heavy and light); pipe pliers; assortment of screwdrivers 3 to 16 inches; chain nose pliers; conduit bender (swager); lineman's pliers 8 inch; off-set screwdriver; Phillips screwdrivers (assorted); electric drill with assorted drills up to ½ inch; tap and die set; and lineman's pocket knife.

Before attempting an installation the technician should be thoroughly familiar with the care and use of tools.

Immediately after completing a preliminary survey of material need-

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ed, space availability , etc., the equipment destined for installation should be inspected and bench tested; thus assuring its condition before actual installation.

The recommended installation order of a complete radio installation (installing nearly all available equipment) is: 1. Junction boxes; 2. Panels and sub-panels, fuse receptacles both exterior and interior; 3. Generator and battery (seldom the case); 4. Associated electrical wiring; 5. Antennae systems including loop assembly; 6. Receiver; 7. Interphone system; 8. Transmitter; 9. Marker beacon receiver; 10. Radio compass receiver and 11. Special equipment such as absolute altimeter, auxiliary receivers, etc. This order of installation does not indicate that any other sequence is wrong. However, it should be remembered, that in order to affect a speedy and efficient installation it is essential that components "closely allied" (compass receiver, communications receiver, interphone, etc.) be installed in "order." However, where it is found that one component once installed would hamper the installation of another component, then it would be necessary to change the order of installation. And where one component if installed first would later aid in the installation of one or a group of components, then of course, it is given installation priority.

Depending upon the experience of the technician and the amount of equipment to be installed, installation order of components will be governed generally by the type of equipment and the design of the aircraft.

In rare instances where a shortage of equipment components precludes the possibility of an entire installation, components which are a part of a group, viz., receiver group: remote tuning control unit; power supply; filter units; etc., may be installed and a part of remaining equipment installed in order to save time. Later, with the addition of the missing components, a complete installation can be speedily affected.

A word of caution here, however. If the exact dimensions of the missing units are not known it would not be wise to install components which may later deter proper installation. No guesswork should be indulged in if re-installation is not desired, and which, incidentally involves more work.

A junction box is just as the name implies. It is a box containing connector strips to which the wires of an electrical and radio installation are joined, and from which, connection is made to various circuits; obviating the necessity for making many bulky connections. It could be easily called a "distribution terminal," because its primary purpose is that of distributing current.

Installation of the junction box is usually made at the aircraft factory, but in rare instances must be made by the I&M technician. Its installation

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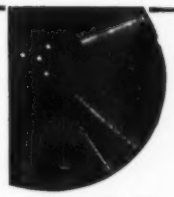

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One-Horse Radio in Action

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is relatively simple to carry out.

A mounting site nearest the available power source is selected with some consideration being given to its location with respect to the equipment it must serve. The box is mounted in a position which will afford easy access to the terminal strips and where a common connector, or test terminals are situated in such a position within the box, making connection difficult, the terminal strip should be remounted. When tying in wires to the connector strips, white adhesive tape should be used for tagging these wires in the standard fashion, i.e., write the circuit number (or wire number) on the adhesive tape near one end of a strip approximately 1 inch wide by ¼ inch long; wrap this strip around the wire beginning with the unmarked end. After the wrap is completed paint the tag with clear varnish. Space is usually provided on connector strips for marking circuit numbers.

Conduit connection to the box is made through appropriate knockouts. Usually, a group of wires are routed through conduit simultaneously and before connection is made each circuit is checked with an ohmmeter or line test buzzer. (When installing any wiring which forms a part of the ship's electrical system, the battery should always be disconnected.) Sharp bends in conduit should be avoided. A swaging machine properly designed and operated will prevent making short sharp bends. The bend, if short, should not be sharp, but should be a gradual one. The effects upon wire rounding a sharp short bend are detrimental in that gradual rubbing off of the wire insulation will soon cause shorting. The rubbing is caused by vibration which must be lessened by properly mounting the conduit. Conduit should he routed as straight as possible without too many turns or bends. When the latter exists it is a difficult job to properly fasten the conduit securely to the aircraft structure. Too, when clamps are used (strongly advocated), tape or rubber shims should be placed between the clamp and the conduit to lessen the undesirable effects of vibration.

Panels and sub-panels (often referred to as connector panels) are utilized when connection between component units of a major unit must be made, or where many connections from a group of major units must be affected. The panels and sub-panels are similar to the junction box connector strips but are not usually designed as a "relay agent" for large currents. These are installed where needed and it is not uncommon to see three or more of them in a medium sized aircraft. They are mounted at a central point between the units to be served as in the case of the junction box. All cables, wire, etc., should be shielded and bonded. (Methods to be explained later.)

Fuse receptacles if not an integral part of the equipment should be in-

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stalled where fuses can be readily extracted and replaced. The exact mounting position is governed by the proximity of the power source and equipment.

The generator and battery are usually installed by the aircraft manufacturer. In the light plane very few will be found. However, if the technician is asked to install them, the manufacturer's instructions plus the assistance of an able mechanic should make the job very easy.

Electrical wiring associated with the generator and battery should be installed carefully, for upon the electrical installation depends the efficiency of the entire radio installation. The correct size wire should be used, allowing at least a 50% overload safety factor. That is, if the wire will carry 40 amperes with all equipment operating it should be capable of carrying 60 amperes in an emergency. Even though the fuse or fuses are considered the "safety valves" in the electrical installation (in some cases, circuit breakers) and will usually take care of overloads, the safety factor is still taken into consideration and allowances made for it.

Wire entering a junction box or panel should terminate in a lug terminal. A wire is never twisted around a connector unless it has first been formed and soldered; even then, a good stable connection does not often result. Conduit should be used wherever possible because it lessens fire hazard and at the same time acts as a metallic shield for the wire it carries.

When peeling off wire insulation (B&S Gauge 16 or smaller), it should never be pinched off with pliers. This practice although speedy does more harm than good. A sharp knife should be used and a circular cut made just deep enough into the insulation to loosen it; then the amount cut can be easily twisted off.

Routing of electrical wires in an aircraft is a difficult job if polarity is not observed, this resulting in magnetic radiation which affects receiver operation. Twisting of wires of opposite polarity, running wires carrying current polarized the same parallel to each other, will lessen the effects of magnetic radiation in that magnetic fields of like polarity are cancelled.

Most aircraft contain the "two wire system," but many will be found to contain the "single wire" or the "grounded wire" system. A system not used often is the "two wire ground return system." There are advantages and disadvantages to all of them.

In the grounded wire, or the "ground return" system as it is sometimes called, radiated interference is lessened but each structural member of the aircraft carrying current must be carefully bonded, much more so than the two wire system. In the two wire system careful bonding is essential but only because various structures may be at a lower or higher electro-

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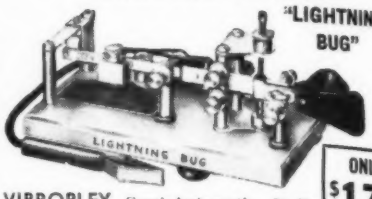

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static potential with respect to each other, causing interference by mutual discharge. It is much more difficult to properly bond and shield a two wire installation than it is a single wire grounded return system. One may think that because the aircraft structure is used as one conductor that it would be more difficult to bond. On the contrary, because there is more wire which is not always routed in pairs, and because the structures of the aircraft tend to re-radiate certain types of interference; especially when not properly shielded and bonded, the two wire system usually occupies more time and requires more material.

In the two-wire ground return system a major job of bonding and shielding presents itself because two separate generators, batteries, etc., are used. And because more ignition wiring (multi-motored installations) is employed, extraordinary care must be taken with the shielding and bonding and all principles which apply to the other two systems must be applied. However, one need have no fear of coming in contact with this system as it is only found on aircraft undergoing a major electrical system re-installation job.

When making wire connections (two wires jointed together) the connecting ends should be soldered, the connection taped and shellacked. The preferable method, however, when many connections will not be "bunched" together is to lug the connecting ends and fasten them together with a small bolt and locknut. This method simplifies trouble shooting in that the two wires can be readily disconnected for test.

All connectors regardless of the type should be taped and shellacked. Connections made to lug terminals in the junction box or panel should be spotted with glyptal, or a good grade of varnish.

When making continuity tests between wires whose ends are widely separated, a simple expedient consists of a buzzer and a pair of phones connected so that the buzzer can be heard if a continuous circuit exists. (A commercial line test buzzer is available and information concerning it can be obtained from any telephone maintenance man.)

After completing the antenna system and making final connection to the lead-in insulators, the receiver and/or transceiver installation is then started.

Tubes are removed from the receiver while making the installation. If holes must be drilled for the receiver mounting and no template has been provided one can be readily made from hard smooth cardboard. Depending upon whether or not the receiver is rack or shelf mounted, mounting frames and brackets should be fastened to the receiver proper before measuring for mounting distances. In case the receiver is to be rack mounted, mounting frames and

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brackets must be removed and measurements taken for the rack assembly which also may house the transmitter, receiver, power and antenna relays, etc. Seldom will one find a rack designed which has provisions for a dynamotor assembly along with transmitter, receiver, etc.

In the preliminary phases of installation consideration was given to mounting space, equipment placement, etc. Accessibility to components of a unit, such as tubes, fuses, vibrator, etc., is of paramount importance. For this reason, when "spotting" the receiver (and if space is limited) every practical means for mounting the receiver should be utilized, so that its components are accessible for service.

All equipment requiring an antenna for operation should be mounted as close to the lead-in insulators as possible. This is especially true of UHF equipment.

Where aircraft design prohibits placing the receiver near its own lead-in insulator and/or antenna switching relay, a compromise must be struck between remote control cable length and antenna lead-in length. If the receiver is directly tuned, then it will be necessary to run the connecting transmission lines by the shortest practical route. If no drop in efficiency will be apparent (as in the case of those receivers covering 200 to 400 kilocycles) it is still wise to use as little wire as is consistent with good installation practices.

If a common antenna is used between receiver and transmitter, an antenna switching relay will no doubt be used. This should be installed as near the antenna lead-in insulator as permissible. In case it would be difficult to install it near the lead-in due to the impracticability of long power lines, then it should be mounted as close to the receiver as possible which in turn should be close to the power source.

Long power supply lines have large voltage drops and make fine conductors for interference. Therefore, when feasible, all power should be routed to the central junction box which is usually installed so that distribution of power over short distances is made possible.

All aircraft radio receivers are especially cushioned against shock by shock mountings. These consist of inverted rubber cups which are fastened to the receiver sub-mounting with snap fasteners (safety slides or Dzus fasteners). When checking shock mounts, whether they hold a rack or an individual piece of equipment, care should be taken to see that these are free. In many instances where deterioration of the rubber has set in, or where the retaining screw is too tight, the mounted unit will receive an unusual amount of vibration which is detrimental not only to tuned circuits, tubes, etc., but also to mechanical structures.

After all holes have been drilled the sub-mounting should be removed from

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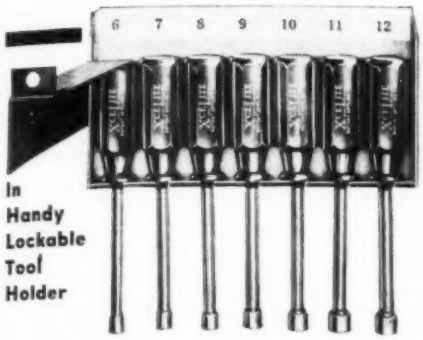

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the main mounting which should be bolted and fastened as tightly as possible to the aircraft structure. The sub-mounting after attachment to the receiver may be attached to the main mounting making certain that all shock mounts are absolutely mobile. Where an instrument panel mounting is being installed no special attention need be paid to shock mounting other than placing rubber washers between the set and the panel. (All instrument panels in aircraft are cushioned against vibration.)

The receiver remote tuning control unit (if one is used) should be mounted as close to the operator's position as possible and be calibrated upon installation. That is, its dial should be "zeroed" with that of the receiver's and allowance made for back-lash if the mechanism is not spring loaded. Above all, the remote control cable should not be tight. A certain amount of play must be left in it to cope with vibration. Clamps holding the cable should be staggered at approximately every 2½ feet of the cable's length. Tape should first be wrapped around the cable covering before mounting the clamps; this prevents noise caused by metal rubbing against metal.

After the receiver and/or remote control unit are installed, mounting of the power supply unit (if the receiver does not contain one) is begun. The majority of the larger receivers utilize a dynamotor which operates off the aircraft battery. A dynamotor is nothing but a motor generator, electrically operated. The smaller receivers make use of a vibrator type (Vibra-pack) power supply which also operates off the craft's battery. Usually, a receiver employing a vibrator type power supply will have this supply mounted on the main chassis with other units.

If the dynamotor supplies voltage to both a receiver and transmitter, then it will be necessary to mount it close to a junction box or distribution panel in order to lessen voltage drop. The same considerations as concern shock mounting apply to all dynamotors.

The power cords to and from the dynamotor should be shielded, taped and shellacked; in every case the shield should be grounded every 12 to 20 inches to the aircraft structure. In case a wooden ship is receiving the installation (a craft whose structure is composed of wood and fabric) a common grounding strip consisting of wire braid (shielding) should be used, and all shields tied to it.

Before installing the dynamotor its lubrication should be checked and commutators examined.

Alternating current generators (110 volts 800 and 60 cycles) will sometimes be found in the larger aircraft. These generators were designed to supply power to equipment especially designed for 110 volt operation. Their installation is usually made at the aircraft factory and the

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Nearly all of the larger aircraft (bi-motored) which carry a large crew and passengers is provided with an inter-com system, or as it is commonly known, an interphone system. When a tube amplifier is used to amplify the feeble electrical impulses from various microphones throughout the aircraft, it generally derives its power from the receiver supply system. The only considerations for the interphone system are: Route all power cables as directly as possible; shield and ground all audio conductors (to prevent cross-talk); mount all microphones so that if they should fall while in flight they will not become tangled with flight control cables; and mount all interphone switching boxes as close as possible to the positions they serve. (Electric cord curlers found in a 5 and 10 cent store may be used on microphone lines to keep them coiled up and out of the way.)

The transmitter installation is not difficult once the receiver installation is in. Its controls, tubes, crystals, etc., should be readily accessible, and because most transmitters designed for aircraft are remotely controlled, no special attention need be given their placement other than that which concerns power line shortness, short antenna leads, etc. However, because higher voltages are used for transmitter operation, special care should be taken to see that adequate insulation of power leads is made available.

Telegraph keys when installed should be situated in such a position so as to offer ease of operation. All key leads should be bonded and shielded if routed for long distances, otherwise ordinary connector cords may be used.

After installing the transmitter the keying relay should be checked and adjusted, tubes placed in their respective sockets, removable tuning units checked for contact by examining banana plugs and tapping them slightly with a small hammer in order to spread the segments for better contact. Perchance the transmitter has been in storage long, all sliding contacts on coils etc., should be cleaned with fine sandpaper "000," and washed with carbon-tetrachloride.

The marker beacon receiver should be installed as close to its antenna lead-in as is practicable, because it operates in the UHF spectrum where RF losses are high. In case a long transmission line is used, its length should be within limits set by the manufacturer. The indicator which is installed on the instrument panel should be directly in front of the pilot and so obvious that it would be im-

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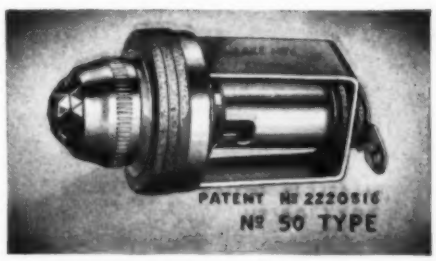

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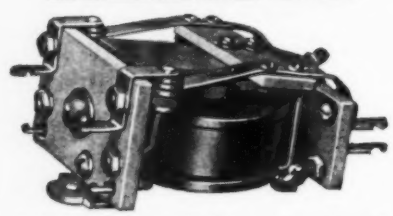

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possible to miss its flashing indications.

The radio compass receiver is installed as close to the loop antenna as possible and in a position convenient for the operator. Its installation differs but slightly from the communications receiver installation. Remote control synchronization is accomplished immediately after installation as is compass calibration. The R-L indicator (if one is used) is always installed near the marker beacon indicator on the pilot's instrument panel. Remote control units are placed near the communications receiver's remote tuning apparatus. Most radio compass units receive their power from small dynamotors which may be found shock mounted on the receiver chassis.

The manner in which special equipment installations such as the absolute altimeter etc., are performed, is dictated by the following: Amount of equipment already installed; design of the aircraft; manufacturer's instructions and recommendations; amount of experience possessed by installing technician; and installation equipment available. It is to be remembered that any radio installation is only as efficient as it is installed. Installations should be performed so that future troubles which develop cannot be attributed to the installation practices followed by the technician.

After an installation is completed, tested and the final stamp of approval given by the technician, the pilot or radio operator is the final criterion. As the equipment is used various electrical and mechanical troubles arise which impair operating proficiency. Upon the maintenance technician (who is often the installation technician) falls the responsibility of keeping the equipment in a high state of repair. He must keep the equipment operating at the highest peak of operating efficiency.

It is said, "Aircraft radio equipment will only operate efficiently as long as its caretaker."

Every aircraft radio installation whether it be a two-way or receiver installation should be inspected and tested before every flight and at regular intervals between flights. Every 60 hours or every 45 days, all equipment should be removed, examined and bench tested. A maintenance log carefully kept will afford the technician a record of service rendered and will often aid him in diagnosing and remedying troubles in other installations. This maintenance log should contain space for every unit serviced with a column for additional remarks.

Each time the aircraft engine is given its overhaul it would be intelligent to check all wiring, junction box connections, etc.

When equipment is removed for bench testing, the receiver should be checked for alignment with a good cathode ray oscilloscope and oscillator (preferably in a shielded room). The

(*Continued on page* 273)

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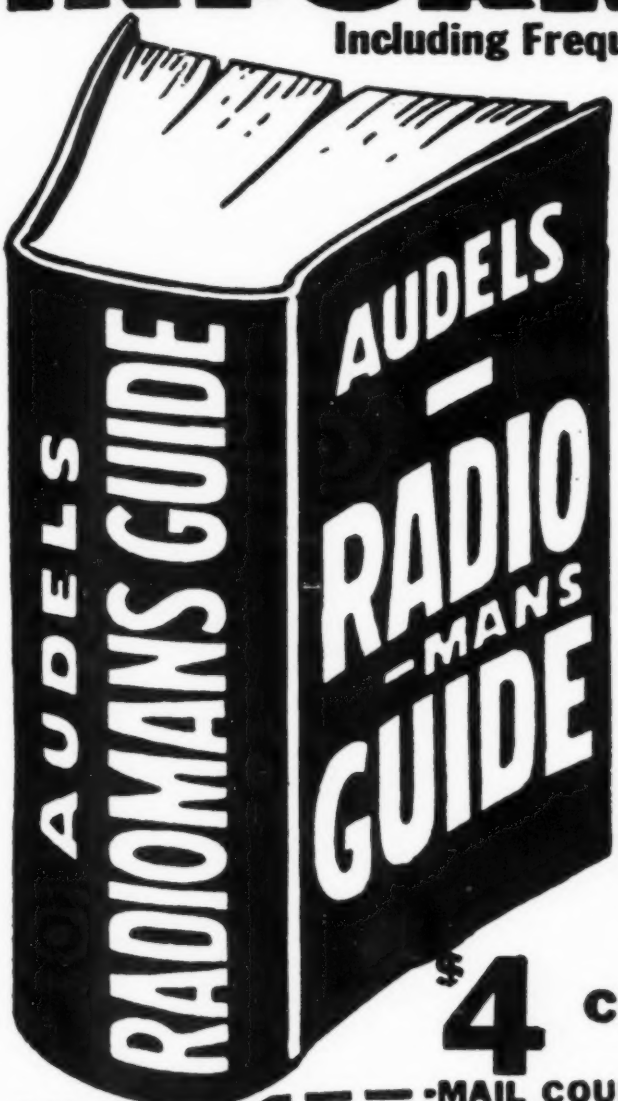

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Aviation Radio

(*Continued from page 270*)

transmitter should be checked for calibration, tightness of connections, deterioration of insulation; flaking resistors (these should have been coated); tuning gear lubrication; and a close visual examination made of all small components such as fixed condensers, for deterioration. (Where ventilation is not adequate, wax filled condensers will "drip," resistors will flake, etc.)

All tubes should be checked with a dynamic and emission type checker.

Individual units should be thoroughly cleaned; all phone plugs polished with crocus cloth; and the exterior of cabinets should be given a light coat of oil which is imediately wiped off. (Typewriter oil is recommended)

Remote tuning equipment is seldom removed but should be inspected in the aircraft for wear and lubrication. Cords such as microphone, headphone, etc., should be examined for wear and breaks and no attempt should be made to patch them; they should be replaced.

Upon re-installation every component of the installation should be tested in the aircraft and final adjustment made. A battery cart should be used in order to conserve the craft's battery. A means whereby connection can be made to the central power system of the aircraft readily is by utilizing alligator clips which are clipped to the power terminals in the junction box. A battery box should contain two batteries connected in parallel to furnish adequate current for long periods.

Dynamotors and vibrator power units often give trouble if not properly taken care of. Depending upon the manufacturer's recommendations as to service procedure, the dynamotor's end bells should be removed about every 1000 hours of operation or approximately five months, depending which comes first, and commutators examined which should be a light chocolate brown in color. (Refer to: Aircraft Generators . . . the same considerations apply to dynamotors.) When lubricating a dynamotor the manufacturer's specifications for the type of lubricant which should be used, should be adhered to.

Overheating of dynamotors can be lessened by removing end bells during operating periods. In case a separate dynamotor is used with the transmitter, a switch for turning the dynamotor off and on should be installed either on the microphone or within reach of the operator. Most microphones come equipped with switches which actuate a relay which in turn controls the dynamotor and audio circuits. A "dead dynamotor" may be caused by any one of a group of troubles among which are: blown fuses; defective switch contacts; defective re-

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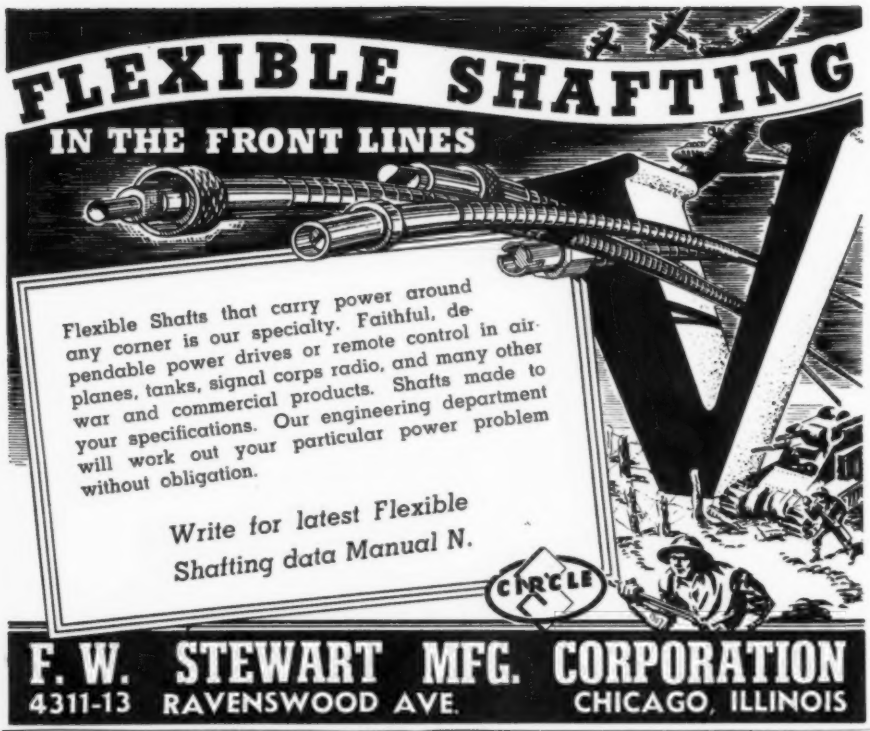
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lays; shorted filter condensers; shorted choke coils (which will generally blow the fuses); defective plug contacts; and shorted commutator segments.

After a dynamotor has been inspected and overhauled, it should be tested for noise. A cathode ray oscilloscope should be utilized but when one is not available, an ordinary receiving tube, such as the '30 connected as a diode rectifier (grid tied to plate), may be effectively utilized. The dynamotor's output is connected to the input of the rectifier thru a small condenser. A pair of headphones are connected to the output of the rectifier. If noise is present in the output of the dynamotor it will easily be heard in the phones. Noise can be caused by defective filter units; dirty or worn commutators, loose plug connections, intermittent contacts caused by vibration, etc.

A commercial vibrator tester should be used to test all vibrators. Shorted condensers, defective rectifier tubes, etc.; all contribute to vibrator inoperativeness. Dirty or worn contact points on vibrator reeds will cause noise, and the unit used for testing for noise just described can be used to good advantage. If a vibrator is sealed, it should not be touched; on the other hand if it is assembled with screws and a vibrator tool set is available it may be disassembled, cleaned and adjusted.

When shooting trouble in a radio installation, check all simplest causes of trouble first. That is, where a fuse might be suspected, don't take the trouble to remove the battery box cover and test the battery!

There are many troubles which occur in an aircraft radio installation and only by experience can the technician solve them effectively and quickly. By pursuing a systematic course when trouble shooting, using proper instruments correctly and making mental notes of the trouble found for future reference a technician can solve any and all maintenance troubles which may arise.

The aircraft ignition and electrical systems are potential transmitters of undesirable receiver interference. This interference takes two principal forms, viz., conducted and radiated interference.

Conducted interference is that interference which enters the craft's radio receiving system through the low power supply circuits (electrical system). Radiated interference is caused by radiation from the ignition system of the aircraft directly or indirectly.

A simple method for determining which type of interference is present is given: Take a short piece of wire, attach it to the receiver antenna post after removing and grounding the lead-in, and attach it to the nearest structural member which has good electrical connection to the metal mass of the aircraft. Start the aircraft engine and listen to the receiver. If interference is heard, it will more than likely be conducted interference. When the wire is removed from the

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receiver and noise is heard it may be radiated interferences. If the interference stops when the wire is grounded, it is radiated interference. In some installations both conducted and radiated interference will be heard.

For determining which part of the aircraft is radiating, construct a coil of number 18 annunciator wire wound on a form approximately 2 inches in diameter and about 4 inches long. Fasten this coil to a bamboo pole about 8 feet long. Use a shielded wire and connect one side of the coil to the shield and the other to the wire. This wire should be 30 or more feet in length. Now take the free end of the wire and connect it to the receiver's antenna post and ground the shield near the receiver. Start the engine and have an assistant listen to the receiver as you place the coil near the suspected radiating member. When maximum noise is heard in the headphones, stop the engine and examine the offending part closely. Broken shielding is very hard to trace and can cause much trouble. The device just described (Probe Antenna) in most cases will locate nearly any break in shielding, and radiation from any structural member.

All spark plugs should be shielded; high tension cables shielded and bonded to the aircraft; magneto housings grounded and preferably shielded (even though adequate shielding is nearly always provided an additional amount of shielding will in no way affect its operation); all members of the aircraft which are attached by means of bolts and bonded together should not have a contact resistance of less than .001 or more than .004 ohms; all connecting cables should be bonded to the aircraft as well as their shields if practicable.

In order to prevent or lessen conducted interference, special care should be taken with bonding operations. If bonding will not lessen it, then all condensers on the generator or generators, in control boxes, etc., should be checked. As a last resort, a filter consisting of choke coils bypassed to ground inserted in the aircraft power supply between source and load should be installed. A filter if properly constructed using the proper components will nearly always reduce or entirely eliminate conducted interference. In some cases it is necessary to employ two filters; one at the offending source and one at the receiver. If after bonding and shielding the aircraft thoroughly, noise still is heard in the headphones when the engine is operating and tests indicate that the noise is neither conducted or radiated interference, check all tubes on a dynamic tube tester having provisions for testing tubes for noise. In many cases tubes will be found which are affected by vibration. Because internal tube elements are close together vibration will affect them causing noise; and sometimes only a definite

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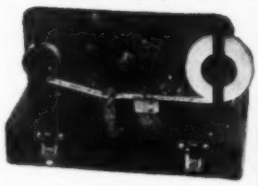

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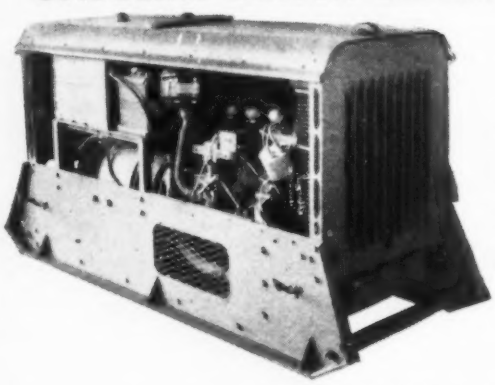

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vibration period will cause it to appear. Tapping the tube with the fingers or a pencil upon which has been wound rubber bands will sometimes locate the offending tube.

If a trailing antenna is used with the receiver and noise cannot be located by the usual methods, suspect the lead-in. Constant reeling in and out of the antenna wire sometimes wears through the fibre fairlead; as the engine operates, vibration is produced which affects this lead and causes a "high resistance short" which is intermittent in nature, producing noise. (Inspect the fair-lead bushing)

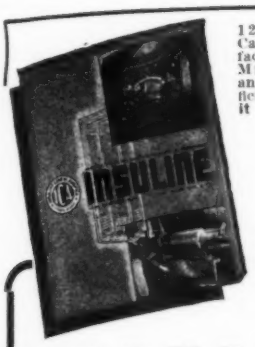
Another source of noise is the antenna switching relay. If the points are dirty and pitted, vibration will cause intermittent noise to appear in the receiver output. Dressing down the points and adjusting the point spacing will usually cure this trouble.

During the last two years, many aircraft radio manufacturers have been making aircraft radio equipment which is portable in nature; especially receivers. The receivers can be used in the home or office and in the aircraft. Operated from dry batteries which will give up to 100 hours operation they are designed for the reception of beacon signals, airport traffic control frequencies, aircraft emissions, and broadcast frequencies. If they do not operate properly in an aircraft, they are a source of trouble to the technician.

Primarily the aircraft owner purchased the set because it would save him the expense of installation and because he wanted a dual-purpose receiver. However, he sometimes will expect a great deal from that set because he feels that it should perform equally as well or better than a permanently installed unit. He is wrong and it is up to the technician to diplomatically advise him why he is.

Usually the portable receiver will receive the ignition system of the aircraft as well as it will the local beacon station much to the dismay of the aircraft owner.

The technician can of course bond and shield the aircraft but the aircraft owner feels that it would cost too much (approximately $20.00 for an aircraft the size of a Beechcraft and about $8.50 for one the size of a Taylor Cub), but still he wants to get away from the intolerable noise he hears every time he takes a flight. In order to satisfy these "hard to please customers" the technician will do everything but a complete installation of shielding, bonding, etc., and in the long run would have been better off if he had done the complete job because his half measures only made the noise worse. There is one way to get around this. Place spark plug shields on the plugs, double bond the magneto housing to the nearest all metal member, shield the headphone cord and bond it to the aircraft structure using a piece of braid and an alligator clip. Now if



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these measures don't lessen the interference, the aircraft owner should be advised that he needs a complete bonding and shielding installation; if he still declines demonstrate a permanent radio installation to him and nine times out of ten he will want one himself.

Every I&M technician is a potential aircraft radio salesman because he knows the technical aspects involved. A lucrative field awaits the wide awake radio serviceman; and because of his additional selling experience (if he is a good serviceman) can expect good remuneration.

As more and more aircraft are manufactured, more I&M technicians will be needed! The field will still be young ten years hence.

In order to keep an aircraft flying it takes about three times more ground maintenance personnel than it does actual flight crew members. In some instances, the figure is even higher.

With the advent of the multi-motored aircraft, more ground crew members were found necessary to maintain added equipment. Because the larger ships contained more equipment, this naturally meant more work and greater care had to be exercised in all maintenance functions. Regardless of the amount of equipment, each component had to be taken care of with the utmost regard for the "flight safety factor"; no safety rule could be violated.

The skill and training backgrounds of maintenance personnel in line with common qualificational standards have to parallel that of the pilot.

Sometime ago we said, "Equipment is only as efficient as its operator." This can be enlarged upon by adding, "And the personnel who maintain that equipment, who are cognizant of the many rules of safety which must be followed at all times."

In order for an aircraft to take to the air and operate properly after it is in the air, the pilot knowing all the while that he is flying a ship which can be trusted, ground maintenance technicians must vigilantly exercise their skills, never forgetting that their work, no matter how minute, will eventually present itself through the medium of the flight report if done haphazardly. The final analysis of the daily flight report is the criterion of the efficiency of maintenance personnel.

It is of course granted that electrical and mechanical failures do take place in the normal space of events; these failures in many instances do not reflect on maintenance personnel.

Citing a concrete example: a vacuum tube burns out. Now no one can tell when a tube is liable to become inoperative due to electrical or mechanical failure. However, basing our considerations on prior tube inspections, the tube may have tested a little low and from previous experience indicated that it should be replaced. The technician who failed to

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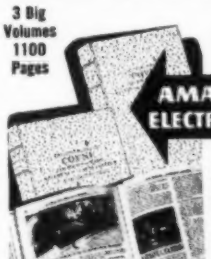

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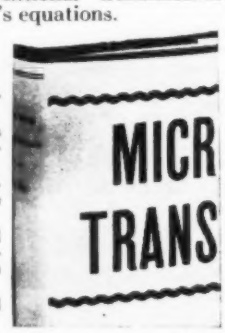

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replace the tube, of course, would be blamed. On the other hand if the tube tested "good" on check, and if after a few hours "went out," and if the tube had not already spent its useful service life, the technician could not be blamed.

The wise aviation radio technician keeps a chart on "tube hours." He knows roughly when a tube will "expire," but not the exact time. He usually makes certain that no tube will be allowed to remain in service past a given number of "safe hours." If he does, and a tube failure occurs, then he will of course be expected to take the responsibility for that faiure.

It would be safe to say that 90% of all tube failures are directly attributable to the negligence and carelessness of the maintenance technician. Preventive maintenance, i.e., that maintenance which obviates likely equipment failures by periodical inspections, repair, etc., must be thorough and covering. The flight report illustrates aptly the type of preventive maintenance performed by ground maintenance personnel and is neither partial to efficiency or negligence.

The aviation radio technician must know how to use and take care of the tools common to his profession. Tools that are used by him both within the aircraft and the shop must be taken care of at all times and their specific uses learned.

Too little emphasis is placed on tool care and use, in certain schools. For this reason this lesson will cover the care and use of tools as well as supplemental material of interest and concern to the aviation radio technician.

Before a student decides to take up the study of aviation radio, and if he plans on doing any actual mechanical work, he should acquire a knowledge of the tools he will use after he has finished his theory and preliminary practice. He must realize that each tool has a specific purpose and should only be used for the purpose intended. In some instances, however, there are exceptions to the rule but these are not numerous. Generally speaking, a tool is designed with but one purpose in mind; when used otherwise, due caution must be exercised.

Too often, a tool is used for a job which not only results in damage to the part being worked on but is detrimental to the tool itself. The man who uses a tool not designed for the job at hand just because the correct one isn't "handy," is a careless and sloppy workman. He not only hasn't prepared for the job he is to do by assembling the tools he will need for that job, but more than likely has failed to make a proper estimate of the job; this being much worse than forgetting essential tools.

The trained aviation radio technician before performing a task will make a reasonable estimation of the work to be done and the tools he will require before he goes on the job.

(To be continued)

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A new Signal Corps Replacement Training Center was opened about September 15, 1942, near Walerga, California, about 12 miles from Sacramento, the War Department recently announced.

Brigadier General Stephen H. Sherrill has been named commanding general of the new training center.

The post has been named Camp Kohler, for First Lieutenant Frederick L. Kohler, Signal Corps, who was killed March 14, 1942, in the Far Eastern theatre while serving with Lieutenant General Joseph W. Stillwell's military mission to China.

Procurement

(*Continued from page* 216)

in the near future, is raw materials. Copper, aluminum, steel and nickel are definitely limited. Shortages of these metals, as well as of rubber, are threatening to diminish production of Signal equipment. But as the shortages appear, substitutions of available resources for scarce materials are being developed. Already there is a growing list of change-overs, from aluminum to iron, leather to canvas, etc.—all a testimony to the ingenuity of Signal Corps engineers as well as that of private industry. Close liaison with the War Production Board, the Army-Navy Munitions Board, and other Army and Federal agencies has also resulted in measures designed to keep production moving.

American and allied soldiers in all corners of the world look to the thousands of officers and civilians engaged in the task of procuring Signal equipment to deliver the weapons of victory. And the latter, in turn, depend upon the thousands of manufacturers and the 500,000 American workers in the radio and communication equipment industries to make those weapons. The communication equipment industry has risen to the needs of the day. The Signal Corps is pleased at the high degree of co-operation and resourcefulness displayed by its contractors. Most of them appear to grasp the fact that without Signal equipment of the right kind, at the right time, and in the right place, victory is not possible. No less than on any other branch of the Army, final success in the war rests on the Signal Corps. "The message must get through."

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TECHNICAL DATA SALON SECTION

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75 Operator wearing new type diaphragm gas mask. Voice comes through clear and distinct to the push-to-talk microphone.

76 Ample stocks of wire of many sizes must be available to the Signal Corps.

77 Temporary telephone cable is unreeled during enemy gas attack.

78 Top: Releasing six-foot meteorological balloon. Girl holds parachute which will open when balloon bursts.
Bottom: Feminine observer follows drifting balloon with theodolite and computes wind condition of upper air.

79 The outer conductor of a lead-covered telephone cable receives its final seal.

80 Top: Wigwag flag communications compared to Walkie-Talkie radio.
Bottom: Another later type one-man transmitter - receiver. Technicalities must be withheld.

81 Forward into battle go our tanks—equipped with latest FM communications equipment.

82 Top: This maze of delicate relays is but a part of an elaborate switchboard.
Bottom: Wire students learn how to erect and wire poles in open country.

83 Thousands of connections must be kept clean and in operating condition.

84 Feminine workers make installations at the Development Laboratory and are highly proficient at their work.

85 Top: This formidable gun is mounted on latest "half-trac." It is poison to enemy tanks.
Bottom: No chance to seek cover—these infantrymen have little opportunity to fight off approaching radio-equipped mechanized units.

86 Pancake inductances were used in early sets. Certain applications permit them to be used for instruction today.

87 This crew from the meteorological section gathers important weather data from charts and observations.

88 Top: Automatic code senders use perforated tape. Their speed is adjustable over wide range.
Bottom: Instructor gives help to individual students and corrects their bad habits.

89 Top: Batteries supply voltage. Adjustable resistors are for load. Meter indicates current flowing through circuit.
Bottom: Mass instruction on operation of portable telephone switchboards at Signal Corps Training center.

90 Voice and code (cw) are used by these operators from their fast-moving scout car.

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